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ABSTRACT

This energy module is intended for an introductory course on energy for secondary school classes. It consists of behavioral objectives, general background, vocabulary, lesson outlines, coordinated activities, and an annotated bibliography of resources. It is intended to provide a fundamental guide for the establishment of the teacher's own energy curriculum. Because the module is intended to include a shop or lab component, the first two lessons deal with a preliminary introduction and safety. (Author)

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SE 029 432

Introduction to Energy

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Editor's Note

This energy module has been designed for a secondary level introductory course on Energy. It consists of behavioral objectives, general background, vocabulary, lesson outlines, coordinated activities,* and an annotated bibliography of resources. It is intended that this module will provide a fundamental guide for the establishment of your own energy curriculum. Because this module is intended to have a shop or lab component, the first two lessons deal with a preliminary introduction and safety.

A comprehensive Environmental Education Bibliography (publications #199) is also available from the Wisconsin Vocational Studies Center. This bibliography is a valuable resource for information regarding energy, ecology, and many environmental topics.

While many people have helped in the completion of this project, special thanks are due to Carrie Olson who typed the final manuscript.

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*All Activity Masters in this module are adapted from The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C. 20461.

Introduction

It seems as though even the most skeptical non-believers of the energy problem are suddenly faced with the cold reality that there is a problem that is here now, and will continue on into the future for many generations to come.

Education has been relatively slow to response to this situation. Also, due to the lack of general knowledge and basic public apathy the problem seems to "swell". So it is time that all educators, whether you teach History, Home Economics, Industrial Education, Science, etc... take the problem at hand and implement energy related curriculum materials into your classroom.

During the past two years there has been a multitude of energy related curriculum materials being put out by government, industry, and education. Most materials are free and relatively inexpensive to purchase. In any case, utilize these materials as well as your own resources.

It is in the intent of this booklet to be used as resource material in building your own program. The module is NOT intended to be the "perfect" energy curriculum mode. Use the materials inside as they apply to your particular situation. Remember, there are many different ways to teach energy education. Develop a program that suits you and your students needs.

We are already ten years behind and have no time to waste!

Once you "get into" your energy curriculum, I'm sure you will find it a most enjoyable and exciting area. If I can be of any assistance in helping you set-up, organize, or evaluate your energy curriculum, please feel free to contact me. I'm sure always willing to help. Good luck!

Fred Posthuma
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Westfield, Wisconsin

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RATIONALE

The energy crisis came to national attention with the fuel shortage in early 1974. The problems related to energy and power are ever so present now, and will continue into the future.

Education is in need of a program in energy developed to inform the students of problems related to energy, and give them opportunities to explore and experiment with possible solutions. Career opportunities must be explored to create a student awareness as to the jobs available in this new and emerging field. Also, it is imperative that students learn good conservation techniques if we are to continue to enjoy our present standard of living.

Lack of information and general public apathy create an immediate problem. Energy education is imperative to human survival and industrial advancement. It is time to bring about attitudinal changes and conceptual development as they relate to the energy and power field, and to focus our attention on educating our students in the exploration, experimentation, and skill development of energy.

GENERAL COURSE OBJECTIVES

1. To work and experiment with energy systems to gain an understanding of energy sources, conversion, transmission, storage and control.
2. To understand the interdependence of society and the availability of energy.
3. To provide career information for entry into energy related occupations.
4. To develop positive attitudes in relation to safety and work habits.
5. To provide an insight into the environmental effects of energy.
6. To develop positive attitutes in the use and conservation of energy.
7. To develop problem solving and creative techniques in working with the energy systems.

BEHAVIORAL OBJECTIVES

1. Given a lecture and preliminary course material the students will be able to discuss intelligently the meaning of Industrial Education, and how energy relates to it as evidence by oral discussion with the instructor.

2. Given a lecture and preliminary course handout material the student will become familiar with policies relating to clean-up, dicipline, attendence, tardiness, assignments, and other such information being evaluated on a continuous basis throughout the year by the instructor.

3. The student through lecture and discussion will be able to draw, label, and explain the energy flow chart with 100% accuracy as evidenced by the instructor.

4. The student through lecture and discussion will be able to identify and expound upon in writing at least five safety precautions as evidenced by the instructor.

5 Through lecture and discussion the student will form attitudes and formulate positive opinions about the energy dilema being evaluated through oral discussion with the instructor.

6. The students will be will be able to compare their life style to that of their parents or grandparents as evidenced by the completed interview on the handout: "The Good Old Days?".

7. Given a lecture and discussion the student will be able to list the three targets blamed for the energy crisis on a quiz to 100% accuracy.

8. Given a handout of the energy pie the student will be able to match the % of consumption with the proper sector with 100% accuracy on a quiz.

9. Given a lecture the student will be able to make a comparison of insulation requirements, monetary, and energy savings evaluated by answering related questions on a test with 80% accuracy.

10. Given five modes of transportation the student will be able to choose the most energy efficient mode for each given situation as evidenced by oral discussion with the instructor.

11. Through lecture and discussion the student will be able to identify in writing three needed areas of energy efficinecy and be able to identify the largest single energy consuming area as evidenced by completing a quiz with 100% accuracy.

12. Given a handout called "What Can You Do To Save Energy," the student will be able to analyze energy comsumption at home and make adjustments to conserve energy as evidenced by completion of the handout.

13. The student through discussion will be able to list at least 10 methods of conserving energy in industry and through self-efficiency being evaluated by a quiz with 100% accuracy.

14. Through the application of prior knowledge the student will develop a positive attitude of energy conservation as evidenced by completing an essay not shorter than 1 page and being evaluated by peers and the instructor.

15. Through individualized research and a lecture the student will be able to list in writing the amount of our present resources and each resources future outlook as evidenced by completion of a research paper and be correctly answering related questions on a test with 100% accuracy.

16. Through lecture and discussion the students will be able to list four types of pollutants and explain each as evidenced by completing a quiz with 100% accuracy.

17. With the aid of references the student will prepare a paper not less than one page on the subject of pollution as related to energy and the environment. Evaluation will be by the instructor and peers.

18. With the aid of references and a lecture the student will write a short 1 page report on at least five of the alternate energy sources each report containing its history, present use, operation, and future use. Evaluation will be completed by the instructor when the paper is completed.

Background*

Energy Overview

The availability of energy resources has become a central concern in the United States today. The continuation of life as we know it, of progress, growth and a comfortable standard of living, depends on ever-increasing quantities of energy. We now face the very real problems of limited supplies of fossil fuels, possible energy-related environmental damage, and high costs for developing alternative energy sources. Your students, if they have listened to a television newscast, waited in a line for gasoline or experienced a brown-out, are aware that energy is a concern that must be dealt with.

We have used our inventive genius to produce high-powered vehicles to ride in and transport our freight. We have devised heating and air-conditioning systems to keep our buildings warm in winter and cool in summer. Even in times of economic recession we have managed to keep our machines of production busy. Our food is mass-produced, processed, and packaged. We are cared for and entertained from the cradle to the grave by a steady stream of energy-consuming labor-saving devices.

Few people would seriously suggest that we throw out our machines and return to the "good old days" of horse and human muscle power. Our population has become too large and our social interactions too complex for that to be a realistic proposal. Solutions to our energy problems lie with learning to use our present energy resources more wisely and finding and developing new sources.

We have used our fossil fuels as if they might last us forever. We now know they will not. We need to increase our efforts to convert coal, our most abundant fossil fuel resource, to a more convenient and cleaner form of energy. We need also to begin to act with some urgency in researching and developing nuclear and solar as well as other energy resources.

An understanding of how our past energy supply and consumption has contributed to our present energy problems can help students approach the energy challenge of the future with greater respect. They will see that situations that loomed as serious problems in the past were subsequently solved, and they will better appreciate their role in solving the energy problems of today and tomorrow.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

FOSSIL FUELS: COAL, OIL AND NATURAL GAS

Coal, oil, and natural gas are called fossil fuels because they were formed from the fossil remains of ancient plants and animals over millions of years. Coal, the most abundant fossil fuel in the United States, accounts for about 17 percent of our total energy consumption. Although coal consumption in the industrial and residential sectors has declined in the past 20 years, the use of coal as a boiler fuel for generating electricity has increased. Presently 63 percent of our electricity is generated in coal-fired plants. Coal consumption is expected to continue to increase. However, uncertainty about environmental issues, surface mining regulations, and rising costs will affect the amount of growth in the use of coal.

Oil supplies about 46 percent of our total energy consumption. Until the 1970's this country produces and consumed more oil than any other country in the world. Domestic oil production began to decline after 1970 when new exploration and development diminished. Our consumption, however, continued to increase at the rate of about 4 percent a year. As a result, our reliance on imports rose from 18 percent in 1960 to about 37 percent in 1975. The higher price of oil since the embargo of 1973-74 has stimulated greater domestic oil demand, but a continued effort to increase supply and cut demand will be needed if we are to reduce our imports.

Natural gas supplies about 30 percent of the nation's energy. Natural gas continues to be a popular energy source because of its clean-burning properties, its low government-regulated price, and, until the late 1960's, its abundant supply. Production, however, peaked in 1973 and has been declining since then. Without a significant increase in the price of natural gas to finance exploration and development, production is expected to fall dramatically by 1985.

Over the last 75 years, the United States has switched from using coal to fill over 90 percent of its energy requirements to relying on oil and natural gas for 76 percent of its energy. Thus, the nation now depends on its least abundant energy resources to fill most of its energy needs. The result has been a growing reliance on imports. Our task between now and 1985 is to find and produce more oil and natural gas and to stimulate conservation as our economy is converted to more abundant resources such as coal and nuclear power.

ENERGY RESOURCES FOR TODAY AND TOMORROW

As we look to the future and to possible solutions for our energy requirements, we need to keep two futures in mind. There is the immediate future, extending to about 1985, and the more distant future of the twenty-first century. In this unit, students will become acquainted with the energy resources that may help to supplement our limited oil and natural gas supplies may ultimately provide the solution to our long-range energy problems. For the near future, our best prospects involve the active conservation of oil and natural gas and the intensive development of coal fields and natural gas and oil reserves. These efforts can both reduce energy demand and increase domestic supply. Actions which would improve energy efficiency of automobiles, homes, and office buildings, for instance, will also have a great impact on energy savings during the next 10 years.

By the distant future, we may have overcome our reliance on oil and natural gas, reserving the oil and gas we have for petrochemical manufacturing and for fueling some parts of the transportation industry. Perhaps we will have made the nuclear breeder reactor and the various solar technologies commercial realities. Current investments of capital for research into coal liquification and gasification, geothermal, and other proposed energy sources may well be showing measureable results. And perhaps we will be able to produce massive amounts of nonradioactive nuclear energy as the result of fusion of light nuclei in the hydrogen atoms of sea water to form a heavier nucleus. The long-term outlook, then can be bright indeed.

ENERGY CONSERVATION

Energy conservation is the least expensive, most reliable, safest and least polluting source of energy we can tap. For example, insulating the typical home costs about $300.00 and saves the equivalent of seven barrels of oil a year for the life of the house. Oil saved is as valuable as new oil pumped out of the ground.

Industry currently consumes 40 percent of the fuel used in the United States, and the primary metals industry uses one-fifth of this. By using technologies different from those they now employ, the steel industry, for example, might be able to reduce its fuel demands by 50 percent by 1995.

Further conservation technology figures in the recycling of scrap aluminum, a process which requires only 5 percent of the energy required to refine aluminum from ore.

Forty-five percent of industrial fuel is used to generate process steam. If this steam were used for dual functions, first to generate electricity and then used in the manufacturing process, more electricity would be produced than all of that which is currently pruchased by industry.

Transportation is another sector of society that consumes substantial energy - 31 percent of the total amound used in the U.S. The Energy Policy and Conservation Act of 1975 mandates that average automobile mileage must reach 27.5 miles per gallon by 1985. Other steps being considered to conserve transportation energy usage are the greater use of mass transit vehicles, car pooling, and the use of trains instead of trucks to transport freight.

To encourage conservation of energy in the commercial building and residential sectors, a number of legislative initiatives are being considered by Federal and State officials. Included are limited tax rebates for installing insulation and storm windows and doors, and for reducing lighting facilities and intensity in buildings. The use of ignition switches instead of ever-burning gas pilot lights on stoves and water heaters - which, incidentally, account for 10 percent of our annual natural gas usage - is also being encouraged.

ENERGY AND THE ENVIRONMENT: A DELICATE BALANCE

When Ralph Waldo Emerson wrote: "Nature never gives anything away. Everything is sold at a price," he was prophesying what has become a major problem in the development of energy resources, that is, the effects of such activity on the environment.

The environment includes all the conditions, circumstances and the influences surrounding and affecting living and non-living things. The non-living factors, such as temperature, sunlight, soil, water, atmosphere, radiation, amound of living space, and nutrients make up the abiotic environment. Living or recently living things, such as seaweed, food, plants and animals make up the biotic environment. Because many of these elements relate to each other as a part of a chemical cycle or food chain, the total environment becomes like a sweater made up of many stiches - you can't remove one without affecting the others.

Some methods of obtaining energy introduce changes that upset the natural balance of the environment. Some of these changes are chemical; some physical. An example of chemical change might be the introducing of sulfur dioxide into the air as the result of burning coal to fuel and electric power plant. A physical change would be the returning of water used in manufacturing to a stream at higher temperature than the original water in the stream.

Pollution introduces conditions that disrupt the environmental balance and may be unsafe or unhealthy for its inhabitants. Seven main types of pollution are: air, water, thermal (heat), radioactivity, noise, visual, and land disruption.

The consequences of these types of pollution are many. Air pollution, for instance, can damage trees, wither the grass cattle use for grazing, and induce various lung diseases in human beings. Excessive radioactivity can cause long-range climate changes and possibly induce cancer in people. Thermal pollution (artificially raising the temperature of part of the environment, usually water) can change the species of fish living in an area, kill an entire fish population, or even increase the fish population.

The financial cost of upsetting the environmental balance can be great. The Environmental Protection Agency estimates that measureable damages of $11.2 billion annually result from sulfur dioxide and airborne particles alone - more than double the annual expenditures needed for control of these hazards.

But who should foot the bill - both finanically and environmentally?

The issues are complex. When coastal populations are subjected to the discomfort and possible dangers of oil spills from offshore drilling so that inland populations can have more oil, who is responsible for protecting or restoring the environment? Who is to decide if the parks of the western United States are to be dug up to obtain energy resources for other parts of the country? These are issues that your students and their families may have to face someday as voters.

ENERGY PROBLEMS: A PRODUCT OF CHOICE

The current energy situation is a product of past and present choices. Some decisions are those of the United States alone; other decisions - those of the rest of the world. Some are conscious choices while others are outgrowths of changing but linked circumstances.

Increased population worldwide, for instance, triggers additional production and increased energy use. Choices of how to meet this greater demand have placed more strain on available energy resources. The result has been higher prices and changing economic relations among the countries of the world. This unstable trade situation has necessitated choices of our own regarding domestic sources of fuel and related health and safety factors as the development of these sources affects the environment. These decisions, in turn, influence choices of lifestyle and energy usage. Thus, each link of the chain changes the others.

The United States comprises only 6 percent of the world's population. However, it consumes more than 33 percent of the world's energy. Each day, the U.S. uses 200 trillion BTUs - the energy equivalent of more than 34 million barrels of oil, or seven gallons daily for each American - and our energy consumption is increasing by nearly three percent each year. At the current rate of consumption, each American baby at birth can anticipate using 175 tons of coal, 2000 barrels of oil and 7.5 million cubic feet of natural gas in his or her lifetime.

Where does all this energy come from? Through 1950, the United States was energy self-sufficient. However, as population and demand grew (United States population grew by only one-third since 1950, while its energy consumption doubled), the need for importing oil and natural gas increased. In 1960, imports accounted for 18 percent of our energy resources; by 1975, the level had risen to 37 percent; in 1976, for the first time, imported oil surpassed domestic oil production.

The disruption in supply during the Arab oil embargo (from October, 1973 to March, 1974) was an important impetus for the United States to reconsider its energy position. The country is now striving to balance the needs of American society with its wants. The priorities and values that the United States establishes will help determine the outcome of the current energy situation - for itself and the rest of the world, far into the future.

VOCABULARY*

Aeration:	cleaning water of impurities by exposing to the air
By-product:	something produced in the course of making another thing
Combustion:	the burning of a substance to cause it to release its energy in the form of heat
Demand:	the amound people are ready to buy at a certain price
Domestic:	having to do with the home or homeland
Embargo:	government order prohibiting entry or departure of commercial ships at its ports
Emission:	a discharge
Energy:	the ability to do work, to make changes found in the forms of mechanical energy, chemical energy, electrical energy, nuclear energy, heat, and light
Erosion:	the wearing away of soil
Export:	selling or sending goods out of one country to another
Generator:	a machine that generates or makes electricity. It uses mechanical energy from falling water or steam to spin a turbine that turns a coil of wire in the presence of a magnetic field. When this happens, an electric current is produced.
Geothermal:	having to do with the heat of the earth's interior
Geyser:	a spring from which boiling water and steam gush into the air
Incineration:	disposal by burning
Molten:	melted by heat
Nuclear:	pertaining to the nucleus of the atom. When the nucleus of an atom is split in a chain reaction it gives off energy in the form of heat.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Ooze:	soft mud or slime at the bottom of a body of water like a pond, lake or ocean
Organic:	derived from living organisms
Peat:	partly decayed plant matter found in bogs and swamps
Pesticides:	chemicals used for killing insects, weeds, and the like
Petrochemicals:	chemicals derived from petroleum
Pyrolysis:	burning of solid waste at high temperatures without oxygen
Radioactive:	giving off radiant energy in the form of particles and rays by the disintegration of atomic nuclei
Reactor:	the part of a nuclear power plant in which the nuclear reaction takes place and is controlled
Reclamation:	recovery or restoration to a better or more useful state
Recoverable resource:	that portion of a resource indicated by geologic studies as being recoverable but as yet undiscovered and so unproven
Recycling:	the process of re-using some discarded item in a useful way
Reforestation:	planting new trees on land once forested
Reserves:	energy resources which have actually been discovered and can be recovered under present economic and technological conditions
Resource:	something that lies ready and can be drawn upon for use
Respiratory:	having to do with the process of breathing
Seam:	a layer of coal lying beneath the surface of the earth
Seismic:	having to do with the earth's strata breaking (faulting), causing earthquakes
Shale:	a fine-grained sedimentary rock formed by the hardening of clay
Shortage:	a quantity or amount less than what is needed or available

Solar:	having to do with the sun
Steam:	the vapor that forms when water is heated to the boiling point. Jets of steam are capable of driving the pistons in a piston engine or turning the blade of a turbine.
Supply:	the amount of a commodity available for purchase at a given price
Surplus:	a quantity or amount over and above what is needed or wanted
Synthetic:	man-made, rather than of a natural origin
Toxic:	poisonous
Turbine:	a wheel-shaped engine fitted with a series of curved blades - something like the blades in an electric fan. The force of running them. Giant turbines turn the generators that produce the electricity in our electric power plants.

Lesson No. 1: Orientation
Behavioral Objectives: 2
Time: 1 hr.

I. Introduction
  A. Introduce yourself
    1. Background material
  B. Student introduction

II. Shop and classroom procedures
  A. Assignment of seats
  B. Attendence and tardiness
  C. Grading
  D. Discipline
  E. Clean-up
    1. Personnel system
  F. Lockers
    1. Make assignment

III. Shop tour
  A. Let's get turned on!

IV. Summary

References Certain references are keyed with the lessons. The key can be found at the beginning of the annotated bibliography.

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Lesson No. 2: Overview and Safety
Behavioral Objectives: 1,4
Time: 1 hr.

I. Review

   A. Questions

II. Overview of Energy

   A. What is energy?

   B. Why study energy?

III. Safety in the shop

   A. Fire prevention and drills

      1. Use common sense

      2. All rags in cans

      3. Fire extinguishers

         a. Demonstration

            i. Locate

            ii. Pull in

            iii. Depress trigger

            iv. Shoot at base of flame

      4. Drills

         a. Exit quietly and orderly

   B. Clothing and appearance

      1. Shop aprons (may be purchased)

      2. No loose clothing

      3. Always wear goggles

      4. Long hair be controlled

   C. Mis-behavior

      1. No horsing around

      2. Treat those as you would like to be treated

IV. Conclusion

   A. Quiz for tomorrow

References None

Lesson No. 3: Energy Model
Behavioral Objectives: 3
Time: 1 hr.

I. Review

- A. Questions
- B. Quiz on safety

II. Energy model (Chart A)

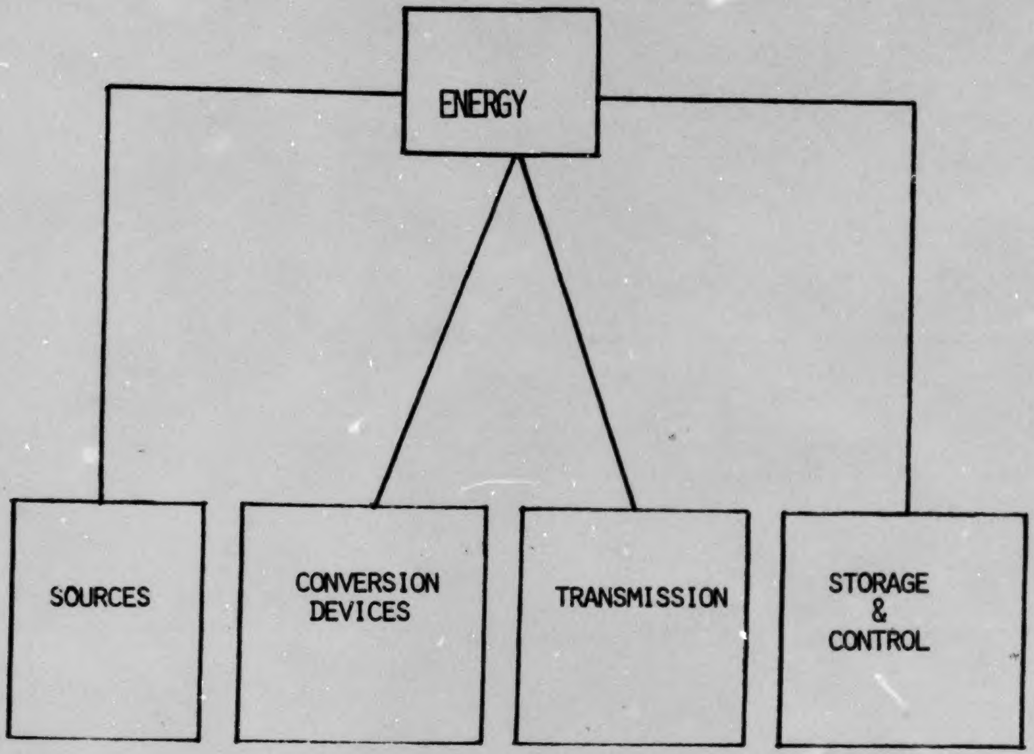
- A. Sources
- B. Conversion devices (Chart B)
- C. Transmission devices (Chart C)
- D. Control and storage devices (Chart D)

III. Trace flow through the model

IV. Summary

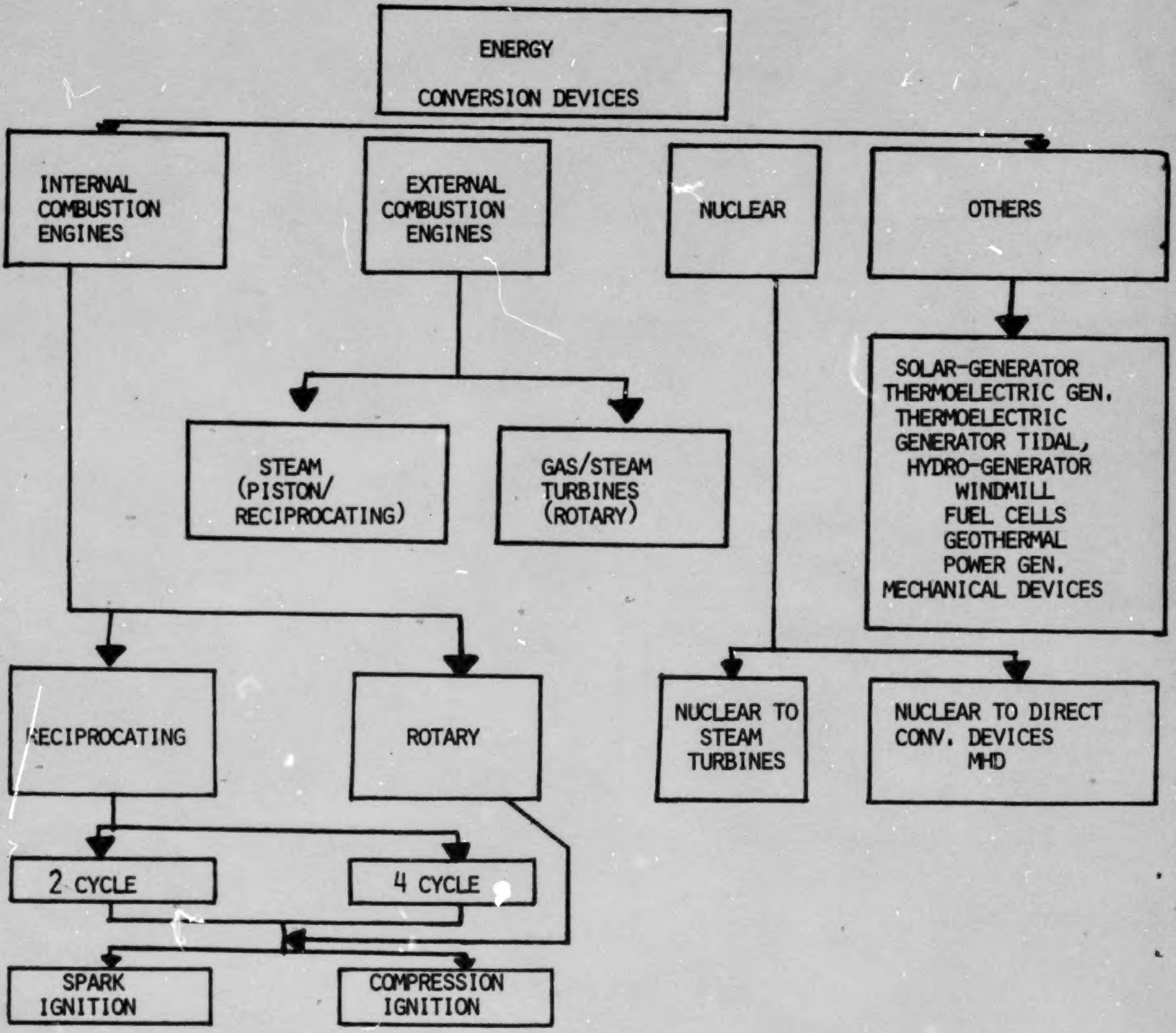
- A. Quiz tomorrow on model

References Ml


ENERGY
SOURCES
CONVERSION DEVICES
TRANSMISSION
STORAGE & CONTROL

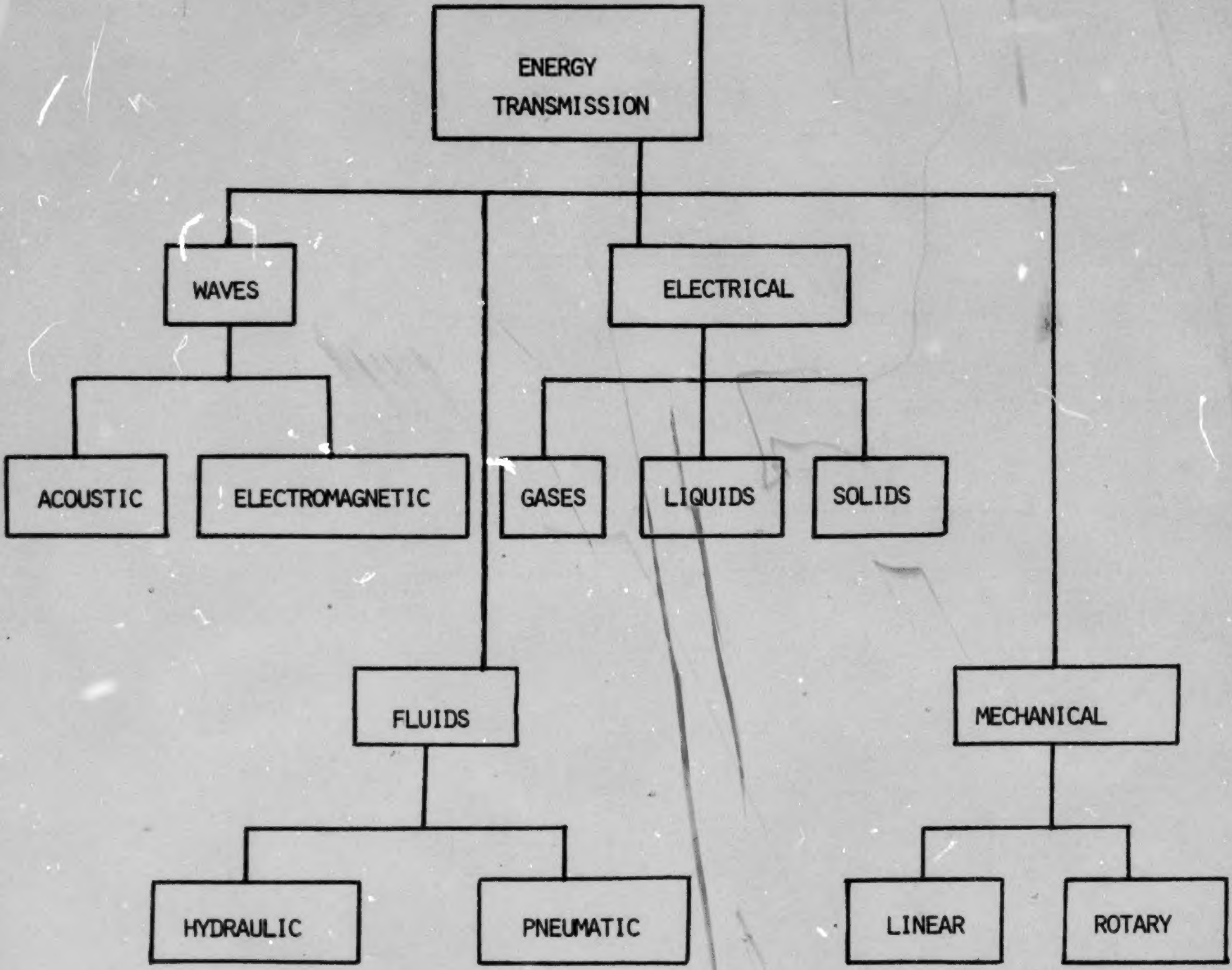
ENERGY MODEL

(CHART A)


ENERGY
CONVERSION DEVICES
INTERNAL COMBUSTION ENGINES
EXTERNAL COMBUSTION ENGINES
NUCLEAR
OTHERS
SOLAR-GENERATOR
THERMOELECTRIC GEN.
THERMOELECTRIC GENERATOR TIDAL,
HYDRO-GENERATOR
WINDMILL
FUEL CELLS
GEOTHERMAL POWER GEN.
MECHANICAL DEVICES
STEAM (PISTON/ RECIPROCATING)
GAS/STEAM TURBINES (ROTARY)
RECIPROCATING
ROTARY
NUCLEAR TO STEAM TURBINES
NUCLEAR TO DIRECT CONV. DEVICES MHD
2 CYCLE
4 CYCLE
SPARK IGNITION
COMPRESSION IGNITION

CONVERSION DEVICES

(CHART B)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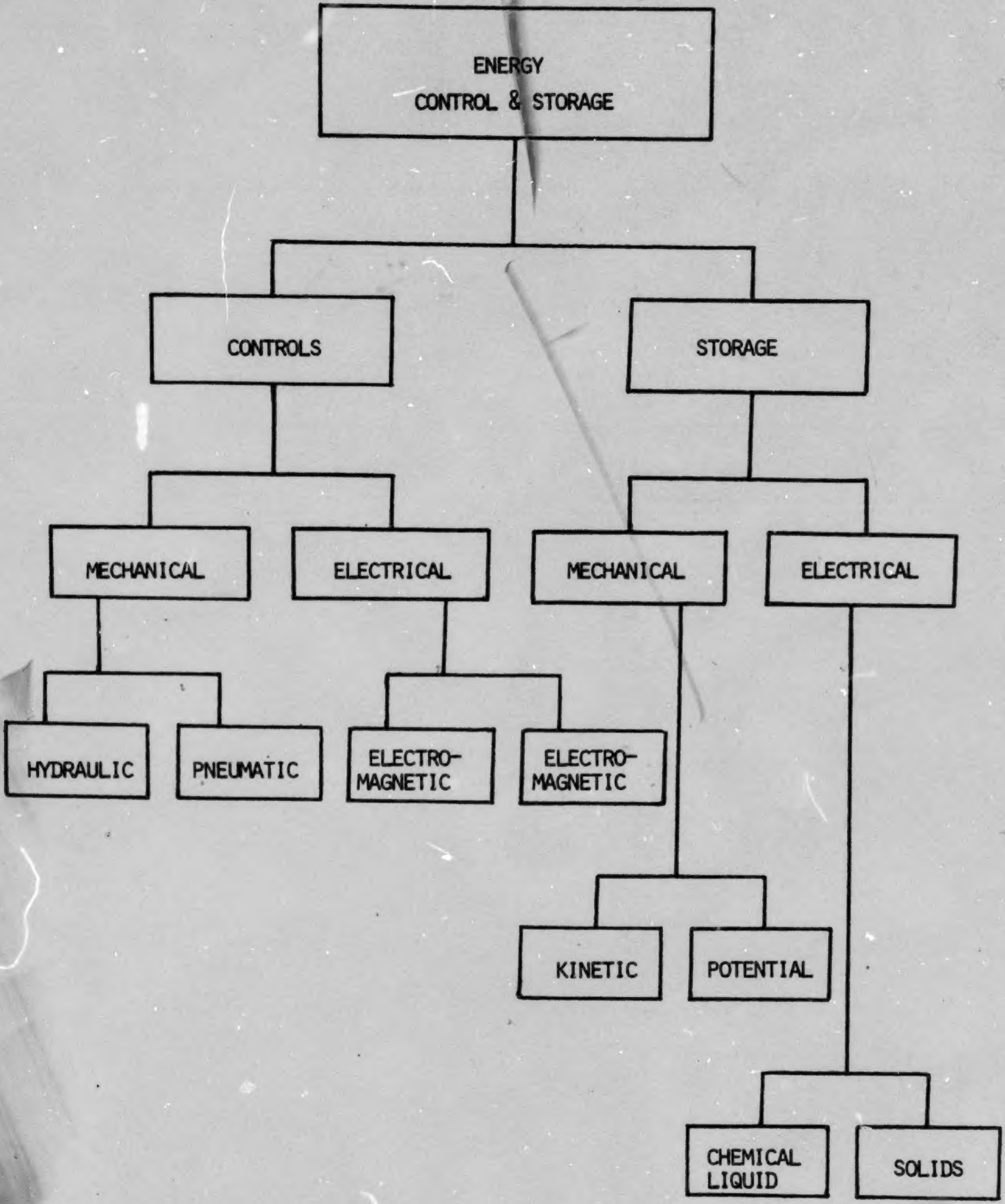
ACOUSTIC
ELECTROMAGNETIC
GASES
LIQUIDS
SOLIDS
FLUIDS
MECHANICAL
HYDRAULIC
PNEUMATIC
LINEAR
ROTARY

TRANSMISSION DEVICES

(CHART C)


ENERGY
CONTROL & STORAGE
CONTROLS
STORAGE
MECHANICAL
ELECTRICAL
MECHANICAL
ELECTRICAL
HYDRAULIC
PNEUMATIC
ELECTRO-MAGNETIC
ELECTRO-MAGNETIC
KINETIC
POTENTIAL
CHEMICAL LIQUID
SOLIDS

(CHART D)

CONTROL AND STORAGE DEVICES

Activity 1*

THE ENERGY CHAIN

This activity helps students relate the more general information from earlier units to personal experiences they could actually encounter. They first identify which link in the chain each situation represents, then in small groups brainstorm the conditions of the problem and possible solutions.

1. Situation 1, of course, sets up the hypothetical problem of how to cope with sudden and severe shortages of oil in the U.S. as a result of a stoppage of imports. Some experts predict that the national emergency we would face would be worse than any civilian crisis faced in wartime. Industry could grind to a halt; stores, schools, hospitals could close; food shortages could quickly develop. The government might have to institute rationing and allocate available fuel to selected users. Have students suggest who should have top priority.

2. The next situation poses a problem that may be very familiar to your students - the crowded classroom. Here is population growth close at hand. Do students, in this situation, have a choice about their population growth? Will the larger class population create a need for more goods and services? Where will people sit? Perhaps the school will go into two sessions. Can the school system afford to pay the teachers overtime? How does an increased population affect energy use?

Students may want to move from this population problem to a discussion of the growing numbers of people all over the world - and particularly the emerging nations who require increasing energy resources for their developing technologies.

3. Situation 3 presents two issues in the delicate balance of environmental concern: the need for energy in urban areas and the desire to preserve the beauty and natural ecology of a wilderness recreational setting. Class members may want to debate which concern has priority. Is there a compromise?

4. The food production industry uses more than 12 percent of the nation's fuel budget. Increases in productivity per acre of land, in the use of farm machinery and food processing and preparation raise the rate of energy consumption. Students may be interested to learn that it takes the equivalent of a half-glass of diesel fuel to put one glass of milk on the table; two pounds of coal to produce a one-pound loaf of bread; three pounds of coal to produce one pound of hamburger. Farmers use almost as much fossil-fuel energy in the

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

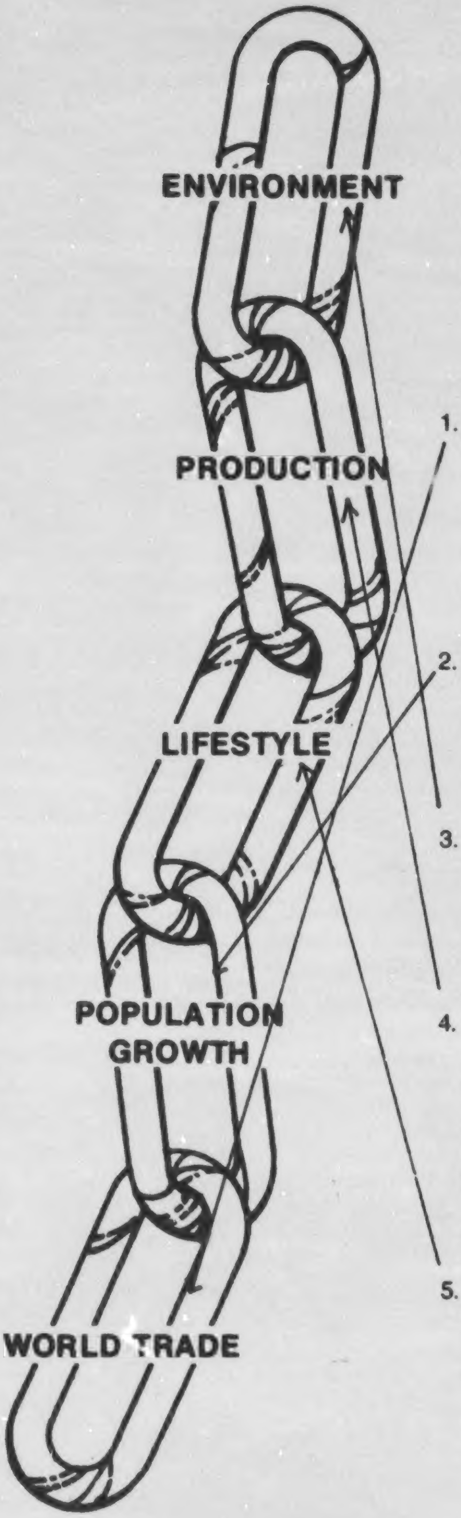
form of fertilizer as they do to operate all of their tractors.

Nearly twice as much energy is used to process foods - cutting, washing, cooking, canning, freezing, drying, packaging - as it took to grow it. Transportation, storage, refrigeration, and preparation of food in the kitchen takes twice as much again. Students might suggest some of these solutions: greater use of animal manure for fertilizer, more hand labor, the planting of home gardens, fewer processed and convenience foods, people eating more vegetable/grain products (lower on the food-energy chain than meats).

5. Accommodating ourselves to the less convenient mode of public transportation rather than private automobiles will require a real change in American lifestyle. The entire transportation sector uses more than 40 percent of our energy budget. The passenger car accounts for 21 percent of this. Fifty-six percent of all commuters drive to work alone; only 14 percent use public transportation. Over half the land in many cities is devoted to roads, parking lots, garages, and service stations. Transportation energy use could be cut in half if commuters used buses instead of cars. Ask students to discuss how people's behavior patterns could be changed regarding the use of their private automobiles.

Activity Master

The Energy Chain



Population growth, production of goods and services, dependency on foreign oil supplies, environmental health and safety, and the effect of these on our lifestyles—each of these is a link in the chain of energy use. Each is part of the energy challenge.

Draw a line from each short story to the appropriate link. Form small discussion groups. With others in your group, define the problem in the following situations and discuss what your solutions might be.

1. Time: One possible day in the future. Canada has decided to stop exporting oil. Some of the other oil-producing countries decide to band together and withhold oil in order to raise prices. U.S. supplies of oil are suddenly cut in half. There is no milk or bread in your house, no gas in the car, and you live 5 miles from the nearest store. What kinds of problems would you and your community face if there were a serious oil-shortage? How could you solve these problems?
2. Each year the number of students in your classroom increases. This means more seats in less space, more noise, less personal help from your teacher. A new business has opened in your town, employing 300 people. Suddenly, your class size has doubled. How will this affect you and your school?
3. A large utility company is planning to build an electric generating plant right where you and your family camp and fish every summer. The coal resources are nearby (mining hasn't started yet, though) and the city 500 miles away is desperately short of electric power. Should the plant be built? Why or why not?
4. Your uncle manages a large farm that produces many food products. He operates tractors and giant combines; he runs a gasoline-powered irrigation system, cow-milking machines and crop-drying equipment. He uses fertilizers made from petroleum. Because petroleum is scarce, his costs have more than doubled. If he cuts back on his use of petroleum-based products, he would seriously reduce food production per acre. Is there any way he can cut back on his reliance on petroleum? How can consumers help cut energy needs for food production?
5. The annual operating budget of your city (your public tax money) can pay for either completion of the super highway system or enlarging the suburb-to-city mass transportation system, but not both. Most commuters don't like to ride buses, so the buses are usually only half full. The vote is coming up at the council meeting next week. How should the council vote?

Lesson No. 4: Energy Dilemma
Behavioral Objective(s): 5,7,8
Time: 2 hr.

I. Review
    A. Questions
    B. Quiz on energy model
II. Energy Crisis
    A. Do we have an energy crisis?
    B. Late in 1972 it all began
        1. Oil shortage prompted school closings
        2. Service station closings on Sundays
        3. There was a surge in sale of small cars 40%
    C. Problems did not hit full blown until 1973
        1. Gas company cutbacks
        2. Voltage reductions
    D. End of the line is the consumer
III. Who can be blamed?
    A. Three targets
        1. Government (regulation)
        2. Energy industry (holding back)
        3. Environmentalists (halting the wheels of progress)
    B. Tremendous amount of friction between all three
IV. So, what happened?
    A. Obviously the demand has outrun the supply
    B. Imports have risen, why?
        1. Utilities change over to oil
            a. Sulfer from coal-pollution
            b. Natural gas price hikes
        2. Automobile industry
            a. Accounts for 40% of oil consumed in U.S.
            b. Less efficient converters of gas into vehicle miles
            c. More power consuming accessories
V. Energy Pie
    A. Industrial - 40%
    B. Commercial - 18%

Lesson No. 4 (con't.)

   C. Residential 11%
   D. Transportation 31%

VI. Summary

References B1

Activities 2 and 3*

FINISH THE ENERGY TIMELINE

This activity provides a comprehensive introduction to the modern energy story from James Watt's contribution to the steam engine in 1776 to the many demands for energy today. Each activity sheet includes four 25-year segments, which can later be cut apart and joined into one long timeline. By gathering facts from encyclopedias and other classroom references to complete the statements, students will quickly gain an historical framework from which to move into the concerns of the present day. They can conclude that the changes in lifestyle depicted in bold type in each 25-year segment, the growth in population, and the demand for goods and services are contributing factors to our growing energy dilemma. But you can help them to see that humans have always been problem-solvers and that human inventiveness can help us continue the progress we began in this country 200 years ago.

After students have completed their timelines, ask them to look at them and find the following information:

- the invention that makes it possible to start a car (battery)
- a famous example of hydroelectric power (Hoover Dam or Niagara Falls)
- two kinds of energy that promise great hope for the future (nuclear and solar)
- the energy resource discovery that made the automobile and the airplane possible (Drake's oil well)
- two inventions that make the manufacturing of electricity possible (the generator and the steam turbine)
- a law that recognizes concern for a healthful environment (The Clean Air Act of 1970)
- an early vehicle that used one of nature's highways to transport passengers and freight (steamboat)
- the invention that made the automobile and the airplane possible (the internal combustion engine)
- the energy source that heats most of our homes (natural gas)
- the energy source that lights our homes and runs most of our appliances (electricity)

You may want to add more clues like these to the list or involve your students in making up clues to test one another.

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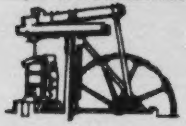
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Finish the Energy Timeline

cut

1780 1785 1790 1795



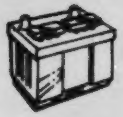
1776

In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is steam

1783

Two men fly in a balloon at Paris, France. The energy used is hot air.

Most people burn wood for heating and cooking and travel by horse or on foot.



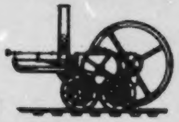
1800

In Italy, Volta invents the battery and gives his name to the volt. The energy produced is electricity.

cut

1800 1805 1810 1815 1820 1825

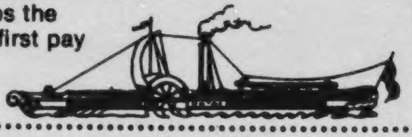
1804



An Englishman, Richard Trevithick, puts James Watt's engine on wheels and rails. He is the father of the railroad locomotive.

1807

Robert Fulton doesn't build the very first steamboat, but he makes the one people first pay to ride on.



Wood continues to supply most household energy needs. But coal begins to do more in factories and railroad engines.

1821

First attempt to develop and market natural gas near Fredonia, N.Y.

cut

1830 1835 1840 1845

1829 An American named Joseph Henry and an Englishman named Michael Faraday each invents a generator. Who is first? Henry. The energy produced? electricity

1837 Americans put new inventions to work. First comes McCormick's reaper then the steam shovel by Otis, and the telegraph by Morse.

Railroads expand rapidly, hauling freight and passengers brave enough to stand the jolts and to risk hot cinders that often fly from the engine into their cars. England is first and America second in railroad locomotive production.

cut

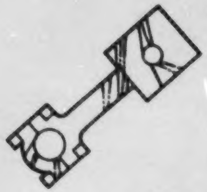
1850 1855 1860 1865 1870 1875

1859

Edwin Drake strikes oil in Pennsylvania beginning the petroleum industry.

1860

Lenoir of France invents the internal combustion engine.



An explosion inside a cylinder paves the way for the later invention of the automobile. An oil strike hastens the discovery of the fuel that will run it.

cut

cut

1880 1885 1890 1895

Coal and wood still furnish most of the energy in homes. Coal-fired "iron horses" (railroads) — and real horses — continue to take most people places. Although the electric bulb has been invented most people still use kerosene or gaslights to read by.

1884

In England, Charles Parsons perfects the steam turbine and advances the development of electrical energy.

1886

Karl Benz builds the 1st successful automobile.

1892

The oil-burning engine is invented by Rudolf Diesel. Eventually, this engine will replace steam-powered ones.

1895

The power of Niagara Fall is harnessed to make electricity

cut

1900 1905 1910 1915 1920 1925

1903

The engine in the Wright brothers' plane is powered by gasoline

1905 Albert Einstein develops a theory for measuring energy and prepares the way for the atomic age.

1910

Ford makes the first Model T car.

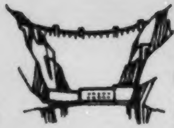
By the end of this period, many new homes have coal furnaces in the basement. And more and more cars appear in garages.

cut

1930 1935 1940 1945

1926

Robert Goddard tests a rocket



1936

Hoover Dam on the Colorado River is built to generate hydroelectric power.

1940

Nylon, a fiber made from oil, coal, and water makes its first public appearance.

1942

In Chicago, Enrico Fermi sets off the first nuclear chain reaction.

Many homes convert from coal to natural gas for heating. Most families own at least one car and some have two.

cut

1950 1955 1960 1965 1970 1975

1952

Bell scientists raise hope for our energy future with the solar battery.

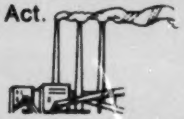
1957

The U.S. gets its first big nuclear electric power plant at Shippingport, Pa.

Demands for energy grow. America gets more people, more homes, more factories and businesses, more cars, more trucks, more buses, more planes. Demand grows faster than supply.

1970

Congress passes the Clean Air Act.



1973

OPEC nations embargo oil and produce an energy crisis.

1976 Americans continue to look for ways to conserve the energy we have and find new energy sources.

cut

Activity 4:*

PRIMARY ENERGY SOURCES

The diagram on this activity master shows six primary energy sources and the work that each one does today. Your students' experience with the timeline should make it easy for them ot say that wood is now rarely used as an important energy source. You might want to ask students to look on their timelines to see how long wood lasted as a major source of energy for home use. Ask if they use any wood in their homes today. Discuss reasons why wood is no longer an important energy resource; then point out that some of the energy sources we use today may one day become as insignificant as wood.

Both the timeline and the primary energy source diagram will help students complete the story about the Spritz family and its use of energy. Some questions may require combining several bits of information from both references to arrive at an answer. For example, it is more likely that locomotive that took Great Grandmother and Great Grandfather Spritz on a honeymoon in 1901 would have burned coal, not wood.

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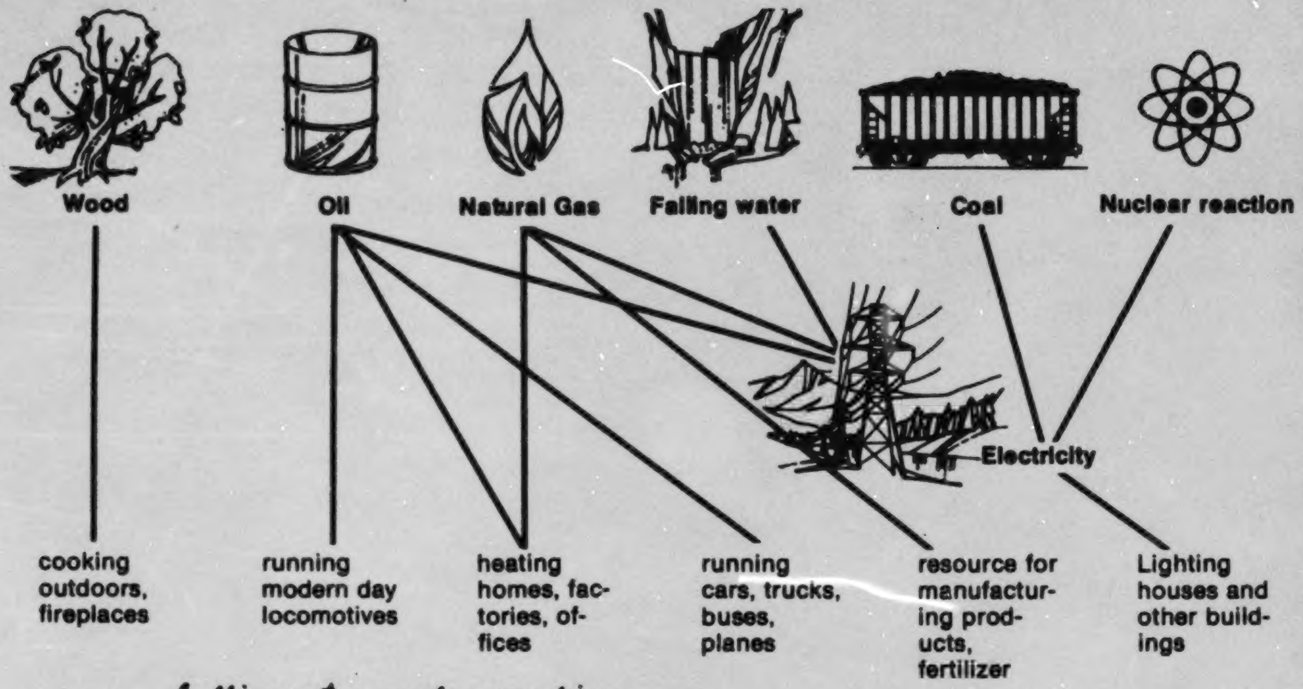
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

Primary Energy Sources


Wood
Oil
Natural Gas
Falling water
Coal
Nuclear reaction
Electricity
cooking outdoors, fireplaces
running modern day locomotives
heating homes, factories, offices
running cars, trucks, buses, planes
resource for manufacturing products, fertilizer
Lighting houses and other buildings

falling water; nuclear reaction wood

The diagram above shows six *primary sources* of energy. Lines connect each primary energy source to the most important work it does. Which energy source is seldom used today? Which two do not involve burning to produce power? Which ones are used to make electricity? oil; natural gas; water; coal; nuclear.

Use the information on the chart and on the energy timeline to help you complete these four stories about the Spritz family.

1. In 1901, Great-grandma and Great-grandpa Spritz went by train to Niagara Falls for their honeymoon. The train engine burned coal to boil the water that made the steam that drove it. The *primary* source of energy was coal. Not long ago their great-grandchildren flew by jet to California. The primary energy source that got them there was oil.

2. Great-grandpa Spritz was one of the first in town to drive an automobile. His Model T burned gasoline The primary source of this fuel is oil. A Spritz great-grandson earns his living driving a big diesel truck. The primary source of this fuel is oil.

3. Four generations of Spritzes have lived in the old family home. At the turn of the century, the family huddled around a stove in the parlor for warmth. Probably the primary energy source was coal or wood In 1928 the family put in central heating by installing a furnace in the basement. The primary energy source was coal. Since 1952 the Spritzes, like most Americans, have heated their homes with a primary energy source that is clean and convenient to use. It is natural gas.

4. Recently a young Spritz asked how the electricity that lights the house and runs the appliances is made. His dad drew a picture of a giant wheel with blades. "This is a turbine engine," he said. "There are a number of these at our city's power plant. These giant wheels turn to make electric energy. Falling water or powerful blasts of steam turn the wheels. You can't get steam, of course, without boiling water. And so a primary energy source furnishes heat to boil the water." The primary energy source that makes most of our electricity is coal. Other sources might be oil or natural gas or nuclear fuel

Activity 5:*

WHERE WE GET OUR ENERGY: HOW WE USE IT

When discussing energy consumption, energy experts generally divide our society into four sectors: transportation (which includes trucks, trains, planes, buses, motorbikes, ships, etc); industrial (factories); commercial (stores, offices, schools, hospitals, theaters, churches, etc.); and residential (homes and apartments). Graph A shows the percentage of our nation's energy used by each sector. It shows, for example, that industry is the biggest user of energy, that transportation runs a close second, and that the rest of the energy pie is divided by the commercial and residential sectors.

It is important for students to see that all of us are involved directly or indirectly in each sector. The exercise that accompanies Graph A dramatizes for them that many of their daily actions contribute to the total amount of energy each of the four groups uses.

In a later unit on energy conservation students will discuss further some ways that they, as individuals and members of society, can save energy. For now, it is sufficient that they become aware of the general areas in which they have the opportunity to take direct action to save energy - at home, at school, and on the road.

Graph B shows the primary energy resources that the four groups on Graph A consume. The data reinforce a fact students have already learned: we have come to rely on three primary sources of energy to meet our needs - oil, natural gas, and coal. It also presents them with a new fact: our two other important primary energy sources - hydroelectric and nuclear - meet a comparatively small percentage of our energy needs. One question below the chart asks students to consider why hydroelectric power will not be a major source for the future. Some students will probably be able to say that hydroelectric power will not be a major source for the future. Some students will probably be able to say that hydroelectric power offers little hope because there simply is not enough falling water to supply us with large amounts of power.

You might ask students why they think nuclear energy represents such a small percentage (2 percent). Some students will probably know that public concern about safety and high construction costs have slowed the production of nuclear energy.

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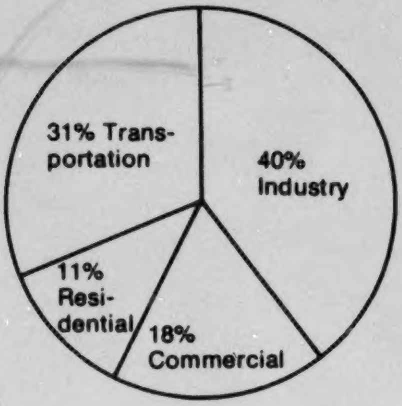
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

Where We Get Our Energy How We Use It



GRAPH A

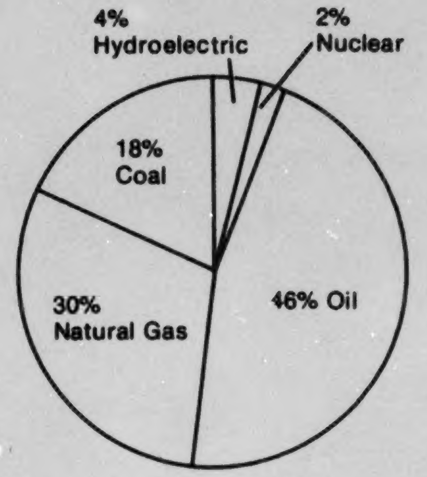
Graph A divides our energy use into four groups. In what group do we use the most energy? industry
What ranks second? transportation
In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns.

(The first one is done for you.)

Every item that includes a product would also be checked under "Industry."

	Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand		✓	(✓)	
3. Fly in an airplane		✓		
4. Switch on air-conditioning	✓			✓
5. Buy a new baseball			✓	
6. Ride a school bus		✓		
7. Blow dry your hair at home				✓
8. Buy a frozen pizza			✓	
9. Ride a motor-bike		✓		
10. Manufacture a motor-bike	✓			



GRAPH B

Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most?
oil

2. Which do we use mostly for heating our homes?
natural gas

3. What energy source provides most of the fuel for our transportation?
oil

4. Which one makes most of our electricity?
coal

5. What is a possible reason why we use so little hydroelectric energy?
not very much falling water

6. Why is electricity not shown on this chart?
it is a secondary source

Activity 6*

HOW LONG MIGHT OUR OIL AND NATURAL GAS LAST?

A mathematical excercise reveals the dramatic limits of U.S. supplies of oil and natural gas. Discuss with the class how they think these limits might affect their own lives and the life of the nation in years to come. Would conservation make a difference?

Some students may want to research and report to the class the uses of natural gas: important because it is easy to transport, nonpolluting, and energy-efficient. Natural gas is used in homes, shops, and factories to prepare food, to heat water and space, and to manufacture many industrial products. It is used as a raw material for fertilizer, antifreeze, plastics, synthetic fibers, solvents, regrigerants, and other chemical compounds.

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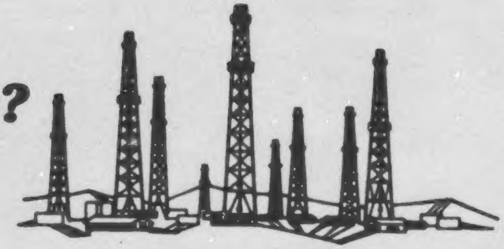
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

How Long Might Our Oil and Natural Gas Last?



Both liquid petroleum, which is more commonly called oil, and natural gas are fossil fuels. Like coal, they were formed by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth.

Gasoline that runs our cars, trucks, and planes is made from petroleum. So are paints, insecticides, fertilizers, and many other manufactured products. Natural gas is a clean-burning fuel that heats many of our homes, cooks our food, and serves industry. Together, oil and natural gas supply 76 percent of our total energy needs.

Read the following items; then see if you can determine how long our oil and natural gas resources might last.

Item #1: During 1975, the United States produced from oil wells about **3 billion barrels** of oil (a barrel holds 42 gallons).

Item #2: The Federal Energy Administration estimates that our proved oil reserves in the U.S. (those known to exist and to be recoverable) is **38 billion barrels**.

Item #3: Many geologists figure that it is fairly certain that an additional **27 billion barrels** of oil reserves exist.

If this amount of oil still in the ground were all we had, and if we did not increase or decrease our production each year, in about how many years would the U.S. run out of domestically produced oil? (Add #2 and #3, and divide by #1.)

(#2) 38 billion barrels
+(#3) 27 billion barrels
65 billion barrels
÷ (#1) 3 billion barrels
21+ number of years

Item #4: The highest estimate is as much as **127 billion barrels** of additional domestic oil still undiscovered.

If item #4 is true, and if we do not increase or decrease our production, how many years might our possible total oil resources last?

(On the back of this sheet, add #2, #3, and #4 and divide by #1. Put the number of years in this space.)

64 number of years

In the same way, determine how long our natural gas resources might last.

Item #5: During 1975, the U.S. produced for use about **20 trillion cubic feet** of natural gas.

Item #6: Our proved reserves at the end of 1974 were **240 trillion cubic feet**.

Item #7: Fairly certain reserves of natural gas are about **202 trillion cubic feet**.

If this amount of domestic natural gas was all the supply we had, it would last about how many years? (Add #6 and #7, and divide by #5. Put the answer in this space.)

22+ number of years

Item #8: The highest estimate of undiscovered natural gas resources is **655 trillion cubic feet**.

If this amount is true, about how many years might our supply of natural gas last? (Add #6, #7, and #8, and divide by #5. Put answer in this space.)

55 number of years

BUT . . . the United States is now using each year almost double the oil that it produces from its own reserves. Where does this additional oil come from? We buy it from other countries.

What could happen if our usage continues to increase each year? We will have to buy more or run out sooner.

What if oil and natural gas usage increases in other countries? Competition for supplies will increase. Prices will rise.

At what time in your life could the U.S. run out of oil and natural gas?

Activity 7*

SUPPLY AND DEMAND: SHORTAGE AND SURPLUS

This activity can only introduce students somewhat superficially to the effects of supply and demand on fluctuating price. Energy prices on the world scene are not so simple. Many complex factors have dictated the energy economics of the past half-decade, the most significant being our growing dependence on imported energy, the availability and price of which are controlled by the Organization of Petroleum Exporting Countries (OPEC).

On October 17, 1973, most of the oil-producing countries of the Mideast placed an embargo on oil shipments. Although the embargo lasted just five months, the industrialized nations of the world are still feeling the economic and social disruption cuased by this interruption of the flow of oil. Prices of all commodities rose and this has contributed to worldwide inflation. Unemployment, at the same time, increased, particularly in energy-intensive sectors. We have been forced to take a hard look at our energy future.

Allow students to fill in the blanks of the story about a small town gas station owner and his customers. Then encourage them to discuss ways in which shortages may cause the price of items in their own shopping experience to increase. Magazines cost more, movies and busfares, too. How are these things connected to an energy shortage? What happens if a storekeeper in their neighborhood has a surplus of an item? Does he reduce its price to get rid of it?

Students might discuss the ways a gasoline shortage reaches out to affect the people of Smalltown. Not only do they have to cut back on their automobile travel, but some people might not be able to drive to work, to school or to the doctor. Will they form car pools, perhaps even lose their jobs because they don't have a way to get to work? Farmers may not be able to get fuel for their farm machinery or to drive produce into town. Can trucks make deliveries of food to the grocers, building materials to the contractor, clothing to the department store? How long will Mr. Smith himself, be able to keep his station open, operating with short supplies? Will the price of other things besides gas go up?

The discussion of possible solutions to their gasoline supply problems will probably turn to conservation as the best immediate answer. Some will get rid of their oversized, over-powered cars and replace them with smaller, more energy-efficient models. People will start to walk more, to bicycle, use public transportation, form car pools, not drive so fast. People in Smalltown may find, as people have throughout the United States, that the number of auto fatalities goes down, that people are moving closer to town, to their work and their friends, that the pace of their lives is slowing down. Talk about these changes and how students feel about them.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

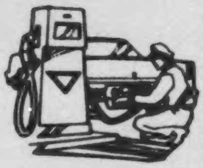
Activity Master

Supply and Demand; Shortage and Surplus

Finish the story by filling in the blanks. Think of the right answer. Then see if it appears in the answers below. Put its number in the blank. Some answers may be used more than once.

POSSIBLE ANSWERS

1. 40
2. lowered
3. supply
4. 200 gallons
5. $3.00
6. 5 gallons
7. shortage
8. raised
9. surplus
10. 160 gallons
11. demand
12. $60.00



Mr. Smith, a gasoline station owner, received 200 gallons of gasoline regularly each week. His 20 regular Smalltown customers were used to buying all the gas they needed. Although some weeks some people bought more and some bought less, average use was 10 gallons a week. The total demand for gasoline each week, then, was _____4_____ As you have seen, Mr. Smith's supply was _____4_____ Everybody was pretty happy about the whole thing. The supply was equal to the _____11_____

Mr. Smith charged 30¢ a gallon for gasoline, a price that was about the same as that charged by the other station in town. Each regular customer spent an average of _____5_____ each week. Mr. Smith received _____12_____ for gasoline. When the other station reduced its price per gallon by a penny, four of Mr. Smith's regular customers deserted him and went across the street. He was still getting a delivery of 200 gallons a week, but now the demand was only _____10_____ He had _____1_____ gallons left over. This unbought quantity of gasoline is called a _____9_____. To get rid of the surplus, Mr. Smith _____2_____ his price. His other regular customers bought up the _____9_____ and took a few more pleasure trips into the city.

Several weeks later, Mr. Smith and the other station each received only 100 gallons of gasoline. Their suppliers were short of gasoline that week. Their customers' demands were still the same, so the pumps soon became empty. "No More Gas!" the sign in front said. Halfway through the week. Mr. Smith had a _____7_____ of gasoline. By still charging 30¢ a gallon, he didn't make enough to pay the costs of his station.

The next week he raised the price to 60¢ a gallon. Even at the higher price, most of his customers still had to buy gas to drive to work and do errands, so he sold all 100 gallons. How much money did he receive? _____12_____ What was the average amount each of the 20 regular customers spent? _____5_____. What was the average amount of gas each customer used? _____6_____

Some of Mr. Smith's customers were on a fixed budget and couldn't afford to spend more than $3 a week for gas. Some customers got to the station after the pumps were empty and couldn't get all they needed. Some of the other station's customers came over to Mr. Smith's station. The demand was greater than the _____3_____ Mr. Smith _____8_____ his gasoline prices again.

Discuss in your class ways in which the people of Smalltown might solve their gasoline supply problem.

Activity 8*

THE OIL WE IMPORT

Until 1973, oil from the Mideast was easily obtainable and inexpensive. Because the price was so low, domestic exploration and production declined. At the same time, demand was growing at a rate of nearly four percent per year. Electricity consumption, moreover, grew at a rate of seven percent each year. The United States, because of the amount of oil imported, found itself in a very vulnerable position.

The price of 73 percent of the oil we import is controlled by the Organization of Petroleum Exporting Countries (OPEC) whose strength is the enormous oil reserves (more than 160 billion barrels) located in the Middle East. OPEC oil now costs more than five times what it did in 1970. Not only does our dependence on foreign oil affect costs of U.S. consumer energy use and consumer goods, but oil has become a major factor in the game of international politics. To relieve our vulnerability to severe supply disruptions and oil price increases, the U.S. is striving toward energy independence by 1985. Energy independence does not mean, however, no imports at all; rather, it means maintaining a level of imported oil that if interrupted in a crisis could be replaced by emergency conservation methods and oil from the Strategic Petroleum Reserve. Up to one billion barrels of oil have been authorized by the Congress to be stored in case of another embargo. A maxiumum effort to increase supply and cut demand could help to accomplish this goal.

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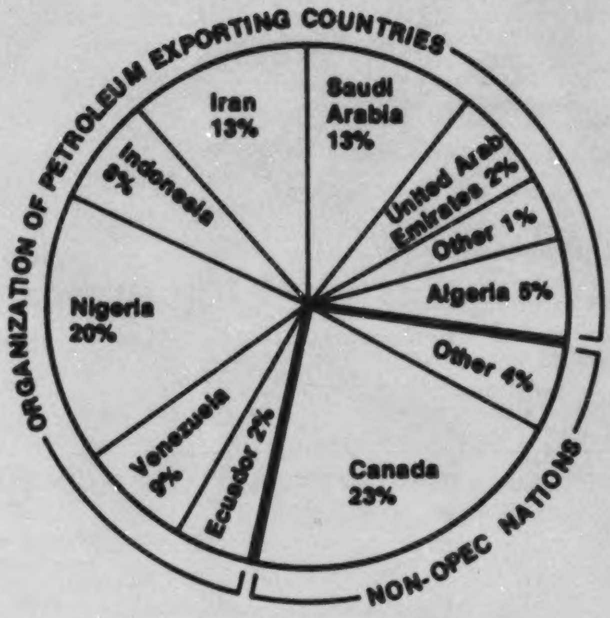
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

The Oil We Import

Because America's demand for oil is greater than its supply, we must buy oil from other countries to help meet the demand. This is called *importing*. During the last five years our imports of oil have doubled, and the cost per barrel has increased more than four times.



PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1974

1. Find each country shown on the graph on a world map. Then list each country in its proper region below. Beside each country's name write the percentage of oil the U.S. imports from it.

North America	
Canada	23%
Latin America	
Venezuela	9%
Ecuador	2%
The Mideast	
Iran	13%
Saudi Arabia	13%
United Arab Emirates	2%
Africa	
Nigeria	20%
Algeria	5%
Southeast Asia	
Indonesia	8%

2. What do the letters OPEC stand for? (The OPEC nations have formed an association to regulate the price they charge for their crude oil.)

Organization of Petroleum Exporting Countries

3. What percentage of imported U.S. oil comes from OPEC nations?

73%

4. Which country sells the U.S. the most crude oil? (This country says it will need to end all shipments to the U.S. by 1982.)

Canada

5. Why does the U.S. need to import oil?

Because its demand is greater than its domestic supply.

Check which of these solutions to our energy consumption problem seems workable to you.

☐ Increase domestic production of fossil fuels

☑ Decrease our demand for oil

☐ Develop new energy alternatives

☐ Increase oil imports to fill growing demand

☐ Stop importing; become energy independent

Other solutions (Could you name some?)

Lesson No. 5: Efficiency of energy use in the U.S.
Behavioral Objectives: 6,10,11,12
Time: 2 hrs.

I. Review
   A. Questions
      1. Three targets
      2. Energy pie

II. Conflicts
   A. Demand for energy is extremely high
   B. Environmental quality goals are high
   C. Unwillingness of people to realize the severity of the problem

III. Resolutions
   A. Development of pollution control techniques
      1. Cost?
      2. Time?
   B. Improvement in efficiency of energy use
      1. Industry
      2. Consumer
      3. Time?
      4. Cost?

IV. Efficinecy in three areas
   A. Transportation
      1. Consumes 31% of total energy
      2. 1950-1970 increased 89%
      3. Why an increase?
         a. Growth in traffic
         b. Less energy efficient models
         c. Decline in energy efficinecy for individual modes
         d. Energy and price data for passenger transport
         e. Energy and price data for inter-city transport
   B. Space heating
      1. Largest single energy consuming function of homes
      2. Average all-electric home space heating uses over 1/2 total energy
      3. MPS-minimum property standards

4. FHA-federal housing administration
5. Electric resistance space heating is more wasteful than is direct combustion heating
    a. Average efficiency of power plants is 33%
    b. Gas and oil are approximately 60% efficient

C. Space cooling

1. Air conditioning ranks third as a major energy consuming function
2. Over 6 million air conditioners sold in 1970
    a. Increasing each year
3. Air conditioners vary in efficiency
    a. EER rating; energy efficiency rating

V. Summary

A. Assignment: Conservation and "The Good Old Days?"
Complete a one page essay on the subject of conservation of energy.

References B2, B6, M1-4

Activity 9*

THE GOOD OLD DAYS?

Activity 9 gives your students a chance to explore the memories of older members of the community. They may wish to find out about the "good old days" by visiting someone in small groups. If some students do not have a grandparent or older adult living close by, they may want to combine their energy-unit interview with a social visit to a local nursing home or senior citizens' center.

Encourage class members to think up additional questions of their own. When the interviews are complete, discuss the answers together and tally results. Ask students if they would like to have lived fifty years ago.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

The Good Old Days?

Interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. Ask him or her the questions that follow and others that you think of yourself.

1. What kind of lights did you use in your home? ______________________
   ______________ How was it heated? ______________________
2. What fabrics were clothes made of? Was clothing harder or easier to take care of?
   ____
3. What sort of washing machine did you have? ______________________
4. What kind of stove (and what kind of fuel) did your family use for cooking?
   ____
5. Did you have a refrigerator? How did you keep your food fresh? ______________
   ____
6. How was food packaged when it came from the store? ______________
   What did milk come in? ______________ Was your milk delivered? __________ How?
   ____
7. What sort of soap did you use? Did it clean as well as the cleaners we have now?
   ____
8. How was your water heated for bathing and laundry?
   ____
9. Did your family have a car? __________ If not, how did you travel? How did you get to school? ______________________
10. Did you have a radio? What did it look like? ______________________
    ______________________ Did you go to the movies? __________
    What kinds of entertainment did you enjoy? ______________________
    ____

(Think up as many more questions of your own as you can. Ask them during the interview. Put the answers on the back of this paper.)

To close the interview, ask these questions and write the answers on the back of this paper.

In what ways is life for you more enjoyable now that we have electricity, plastics, detergents, and other oil and natural gas products?

In what ways did you like the "good old days" better?

Lesson No. 6: Conservation
Behavioral Objectives: 9,13,14
Time: 2 hrs.

I. Review

A. Questions

1. Efficiency in what three areas?

2. What are the conflicts and resolutions?

II. Energy conservation

A. Why do we need conservation?

B. Recently receiving much attention

1. President Carter's energy address

a. Note the opposition to his solutions in Congress

b. Very difficult road ahead

C. Can we entirely eliminate the energy shortage?

1. Can only postpone

D. So what does it require?

1. Political will

2. New technologies

3. Consumer awareness and concern

III. Areas of great need in conservation

A. Industry

1. Industry consumes 40% of our energy

B. Consider careful use of present energy consuming devices

1. Student list

2. Lighting use

3. Air conditioning

4. Adjusting combustion equipment

5. Controlling plant ventalation

6. Loading docks

7. Increase heat efficiency

a. Many furnaces loose 50% up the chimney

8. Etc.........

C. Individual self-suffiency

1. Change personal habits

a. Turn down the thermostat

Lesson No. 6 (con't.)

- b. Insulation
- c. Storm windows
- d. Less recreation
- e. Etc.....

2. Student generated list on board
3. Housing
    - a. Utilization of alternate sources
4. Transportation
    - a. Car pools
    - b. Bikes
    - c. Walk
    - d. Etc.....

IV. Summary

A. Assignment: Present Resources Available
Prepare a paper on the present energy resources available.
Information may be obtained from lectures, books, magazines, etc.

References B1, M1, M2

Activity 10*

SOMETHING TO THINK ABOUT

Part 1 of this activity presents the student with a series of thought-provoking circumstances. Some answers may be quite obvious, others more challenging. Ask students to think of energy-using devices in their own homes or daily routines. List them on the board. Beside each one, list what kind of energy is used - gas, oil, coal, or electricity. Identify as primary or secondary sources. With each item listed, discuss how energy might be saved, e.g., turning off lights, combining washer loads, tuning up the car, and the many other ideas so often reviewed in consumer publications. Talk about the importance of building insulation, which keeps heat in during the winter and heat out during the summer.

Part 2 of the activity illustrates the savings in cost and energy after insulating a residential building. After students have completed the graph and done the simple math problems required, discuss why utility bills might fluctuate from year to year. They might mention such things as seasonal temperature extremes - a very hot summer or a very cold winter, traffic in and out of the house, setting the thermostat higher or lower, closing off unused rooms, and installing storm windows and doors.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

What Can YOU Do To Save Energy?

Part 1:

Brenda's mother and Wayne's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Wayne's father drives alone. Brenda's mother is in a car-pool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they car-pool, how much gasoline does Brenda's mother help save each week? 20 gallons

each year? 1040 gallons How could Wayne's father help save energy? form a carpool

The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy? install an inexpensive timer that turns the lights on and off.

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb), and the number of hours the bulb will last. With this information, how could you select the most efficient bulb? find the bulb that provides the most light with the least wattage.

John and his sister are going to wash clothes. He wants to do his three shirts separately. His sister wants to do them with her five blouses. Which way will conserve energy? washing them together

Why? more efficient use of water, soap, and electricity.

Jack has just come in the door after playing in the snow and feels too warm. He wants to turn down the thermostat until he feels comfortable. His mother tells him to leave it where she has set it at 68 degrees. Who is more energy-conscious? mother

Why? turning the thermostat up and down uses more energy than leaving it in one place.

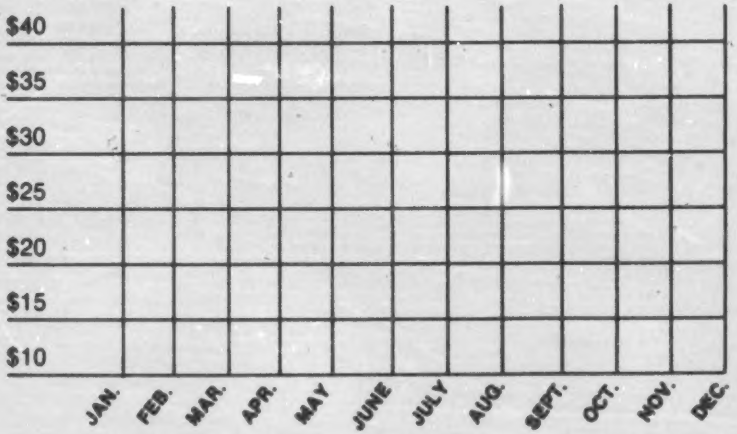
Part 2:

Below are the Hazleton's heating and air conditioning bills for two different years. In 1974, they had no insulation in their home. At the end of the year they had some installed, so the cost of heating and air conditioning in their home went down. In the graph below, place a dot for the cost of each month in 1974. Then draw a line between the dots. Do the same thing for 1975 in red. Compare the Hazleton's savings with insulation.

How much did they save in January? $10

How much for the entire year? $80

	1974	1975
January	$35	$25
February	$25	$20
March	$20	$20
April	$20	$15
May	$15	$10
June	$25	$15
July	$40	$25
August	$35	$20
September	$20	$15
October	$15	$15
November	$20	$15
December	$25	$20



1. At what time(s) of the year is there the highest utility cost? Why? Jan. and July. Coldest and hottest mon
2. At what time(s) of the year is there the greatest savings after insulation? July and August

Activity 11*

IT'S EVERYONE'S JOB

A brief discussion of the four energy-using sectors of our society gives students a start toward completing this activity sheet, which offers conservation methods and asks for follow-through planning. Ask students to name these sectors - transportation, industrial, residential, and commercial - and write each on the board. Ask for several examples of energy use in each sector: cars and trucks, for example written on the board under "Transportation"; the manufacture of plastics and paper goods, under "Industrial"; lighting of stores and offices, under "Commercial"; and setting the furnace thermostat, under "Residential". Next to each, ask class members to note what kind of energy is used, coal, natural gas, petroleum, or electricity.

Ask, then, for ways in each example that could save on energy use. Does conservation take place because less energy is used or because it is used more efficiently? Students may want to discuss not only ways that they and their families can be encouraged to conserve, but also ways that stores, offices, schools, and factories, for example, can be encouraged to conserve. Many conservation methods are more effective if they are voluntary; however, students may be aware that local, state, and Federal government regulations require that certain conservation measures be carried out. Discuss government assistance such as tax credits and other incentives. Consider the role of education, public information, advertising.

Students can then use the activity sheet in one or a combination of three different ways:

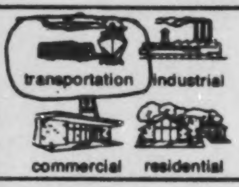
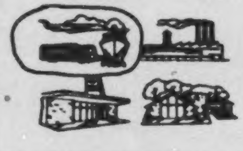
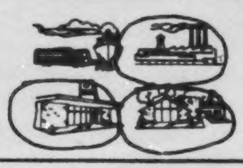
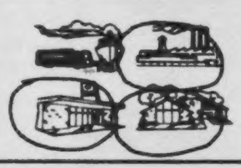
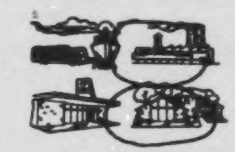
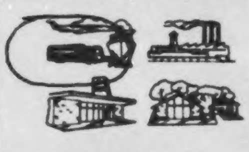
1. working individually;
2. brainstorming in small groups, recording all answers, the reporting back to class;
3. interviewing family members or neighbors as a community-research assignment.

*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

It's Everyone's Job!

Read the idea for conserving energy in the column headed **Conservation Method.** Then answer the questions in the spaces provided.

Conservation Method	**What sector of society? (circle one or more)**	**What energy resources does this save? (write: natural gas, petroleum . . . or coal)**	**Does it use less energy? (Yes or No)**	**Does it use energy more efficiently? (Yes or No)**	**How can we encourage this conservation measure? (brainstorm as many ideas as you can)**
Flying passenger airplanes only when they are full		petroleum	yes	yes	
Shipping freight by train instead of truck		petroleum	yes	yes	
Replacing incandescent light bulbs with fluorescent lights		coal petroleum natural gas	yes	yes	
Reducing heating and cooling where space is unoccupied		petroleum natural gas	yes	yes	
Recycling, steel, paper, glass, aluminum		coal petroleum natural gas	yes	yes	
Developing and using mass transit systems		petroleum	yes	yes	

Lesson No. 7: Present Resources
Behavioral Objectives: 5, 15
Time: 2 hrs.

I. Review
  A. Questions
  B. Hand in assigment
    1. Discussion

II. What we have been using so far for energy sources
  A. Organic fuels - Fossil fuels
    1. Orginated from plants and animals buried millions of years ago
  B. Nuclear fuels
    1. Uranium 235 and 238
    2. Plutonium

III. Basic historical ladder
  A. Wood
    1. Renewable resource
    2. Must use planting and harvesting schedule
  B. Animal wastes
    1. Buffalo chips and cow chips
  C. Coal
  D. Petroleum products
    1. Oil
    2. Gas
    3. Etc....
  E. Nuclear
    1. Application of fision
  F. Other technologies
    1. Breeder reactors
    2. Fuel cells
    3. MHD generators (Magne tohydrodynamic)
    4. Other.....

IV. Oil in the U.S.
  A. Percentage of world crude oil produced in the U.S. has decreased from 44% to less than 19%
  B. Middle East is up from 24% to over 45%

61

- C. Total number of producing wells is down
- D. Exploritory wells have decreased from 16,000 to 8,000 per year
- E. Oil used to be dominated by small business
    - 1. Large conglomerations: possible price control
- F. Why not increase drilling?
    - 1. Not enough rigs
    - 2. Cost of steel has increased tremendously
    - 3. Limited manpower
    - 4. Not attractive enough to oil drillers in terms of input capital to output capital received
- G. Over 1/2 of the oil in the U.S. and territorial waters have been discovered
    - 1. New drilling techniques are required for offshore
    - 2. The problem of oil spills?
- H. Greatest possibility will be found in offshore territorial waters and in Alaska
    - 1. Alaskan pipeline just completed in June 1977
    - 2. Total cost? 8 billion?
    - 3. Cost more than imported oil
    - 4. Was this a rip-off?
    - 5. Governmental regulation and policies

V. Future oil recovery

- A. We will recover about 30% of what we have found
    - 1. Efficiency of recovery systems is poor
    - 2. Economic factors
    - 3. Governmental regulations
    - 4. Nature of oil occurance
- B. Explanation of an oil well
    - 1. Oil contained in intersitices of rocks
    - 2. Porosity of reservoir is not more than 30%
    - 3. Oil and water is mixed and must be seperated
    - 4. Rate flow is slow because of viscosity

C. Historically
    1. Only 1 in 10 exploratory wells have enough oil to justify production
    2. 1 well in 50 has oil reserves sufficient in size to repay its total cost
    3. Secondary recovery techniques have been poor and expensive
        a. Water injection

VI. Gas resources
    A. Estimates
        1. USGS-United States Geological Survey
            a. 1,000 to 2,000 cubic feet
        2. Mobile
            a. Uses computer
            b. 443 trillion cubic feet
    B. Differences?
    C. Cleanest burning fossil fuel; 30% of total energy

VII. Coal
    A. Supplies about 18% of our energy
    B. It is the most abundant of our fossil fuels
    C. The United States has about one third of the worlds supply of coal
    D. The U.S. has about 500 years' worth of power reserves at current consumption
    E. Much coal is high sulfer, which pollutes the air when burned
    F. Most low sulfer coal is located in the western states
        1. Emission standards can be met by burning 1% or less sulfer
        2. High sulfer is 3% to 6% sulfer
        3. About $10 for low sulfer coal per ton

VIII. Nuclear
    A. Briefly explain the process of fission
    B. Supply about only 2% of our energy and about 4% of our electrical generating capacity

C. One ton of nuclear fuel equals the same heat energy as 2,300 tons of coal or 300,000 gallons of kerosene

D. The heat created is 3 million times as hot as conventional coal fired furnaces

E. Problems

1. Thermal pollution

2. Radioactive wastes

3. Safety

i. Existing plants have excellent safety records

F. Breeder reactor

1. Makes its own fuel-plutonium

IX. Hydroelectric

A. Accounts for about 4% of our energy

B. Limited amount of falling water

C. Concern for the environment has limited construction of new dams

X. Summary

A. Assignment: Pollution
Write a short (one or two page) essay on the subject of pollution. Tell what causes pollution, how it could be lessened, and how it affects life.

References B1, M1, M2

Activity 12*

HOW COAL WAS FORMED

In introducing this activity, stress that although our loal reserves are plentiful, with enough to last an estimated 350 years at our present rat of consumption, they are also finite. Be sure that students realize it takes millions of years for coal to form in the earth and that man cannot duplicate the process.

The second part of the activity describes some advantages and disadvantages of both surface and underground mining, the two major methods of coal recovery. The mining method used depends on the location of the seam of coal, its thickness, and the amount and type of overburden. Surface (strip) mining is a fast and efficient way to mine coal near the earth's surface. This is done either by removing earth and rock above the over large flat areas of land surface or by making a cut around the edge of a mountainside (contour-mining) to expose and remove outcrops of coal. The problems presented by surface mining are primarily those of restoring the land areas disrupted by the mining operations.

Underground mining has been practiced for centuries and has always been considered a very hazardous occupation. While modern machinery and technology have reduced or eliminated many of the threats to miners' lives and health, the increases in safety precautions and modern equiptment have contributed to the rising cost of coal to the consumer.

Because of our current need for coal, we can be sure that both surface and underground mining will increase. Though coal from surface mines appears to be cheaper, students should know that damage to the environment also constitutes a cost. Perhaps they will think of some compromise such as surface mining in areas that can be restored and paying for the restoration by increased energy costs, a remedy that is occuring even now.

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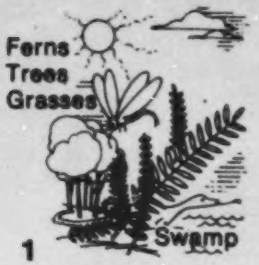
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Fossil Fuels: Coal, Oil, and Natural Gas Activity Master

HOW COAL WAS FORMED



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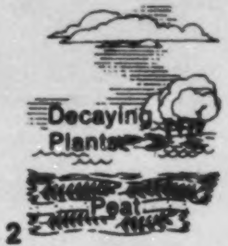

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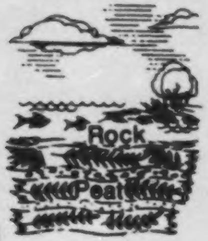

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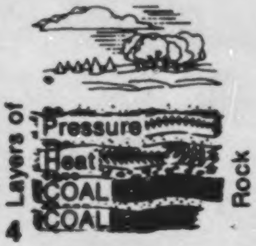

4

PLACE THE NUMBER OF EACH PICTURE IN FRONT OF THE DESCRIPTION THAT FITS IT BEST.

2 When the giant plants died, they formed rotted vegetable matter called *peat*. For thousands of years, plants grew, died, and formed layer upon layer of peat.

4 When the seas were gone again, heat and pressure from the layers of rock changed the peat into coal.

1 More than 250 million years ago, forests of gigantic ferns, trees, and grasses covered vast swamp lands and stored up energy from the sun.

3 Later, when the surface of the earth changed, seas covered the land and deposited layers of shale, limestone and other rock on the peat.

HOW COAL IS MINED

Strip or Surface Mining
Uses huge bulldozers and power shovels to remove coal from a shallow seam near the earth's surface.

Deep or Underground Mining
Tunnel or shaft is built into the earth to the seam of coal sometimes many hundreds of feet below the surface. Workers and equipment remove the coal through the tunnel or shaft.

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal? Write your choices on the blanks at the left, using S (for surface) or D (for deep).

		SURFACE MINING	DEEP MINING
S	1.	Each miner can produce 30 tons of coal a day.	Each miner can produce 10 tons of coal a day.
S	2.	90 percent of the coal in a surface mine can be removed.	50-60 percent of the coal in a deep mine can be removed.
S	3.	In 1974, surface-mined coal cost $11.11 a ton.	In 1974, deep-mined coal cost $19.86 a ton.
D	4.	Forest and fields, along with their topsoil, are turned over before the coal is removed — at a rate of 1000 acres a week. New laws in every state require land reclamation, but the cost is added to the price of coal.	Much less damage to land and environment.
both	5.	Some coal, very close to the earth's surface, can only be recovered by surface mining.	Some coal, very deeply buried, can only be recovered by deep mining.

It would be easy to decide how to mine coal if there were only one set of facts to consider. As you have seen, however, there are many. What would you say is the main advantage of surface mining? economic

What would you say is the main advantage of deep mining? environmental

Can you think of a compromise?

Activity 13*

HOW COAL IS USED

Point out that almost 65 percent of all coal mined in the United States is used to generate electricity. Then ask students to fold their papers in half lengthwise so that only the symbols and boxes on the left are visible. Explain that the symbols, which represent the steps involved in getting energy from the coal mine to their light bulbs, are scrambled. Ask them to draw the pictures in the correct order in the spaces. When they unfold the paper, if the symbols have been drawn correctly, each will be opposite a written description of the process. Be sure that the class reads, preferably together, the information that accompanies each step.

On the back of the activity sheet or on another piece of paper, students can name some of the uses of electricity in their own surroundings. They might consider which of those uses they feel they could live without. Children are often intrigued by or receptive to modifications of lifestyles. Although we probably will never go back to a simpler life without electricity, we will certainly face a period of conservation of resources and reevaluation of priorities. Discuss various alternatives with your class.

Long-distance transmission of electrical energy is an inefficient process but if improved, it could give us additional energy resources. Much energy is lost because of heat and friction and the resistance of the metal wires through which the electricity passes.

Some students might want to research and report to the class just how efficient energy use is in the various sectors such as industry and transportation.

The final activity asks students to describe some facts about our current coal situation either as problems or opportunities. Of particular interest is the third fact: 85 percent of the coal presently being mined comes from the East, but the western reserves contain most of the recoverable U.S. coal.

While substantial western reserves exist, mining of these resources presents problems also. Most western coal requires surface mining, and reclamation of western land will be more difficult because of the low rainfall and sparse vegetation. in that part of the country. In addition, because major industrial centers are in the East, transporting the coal over long distances will be expensive.

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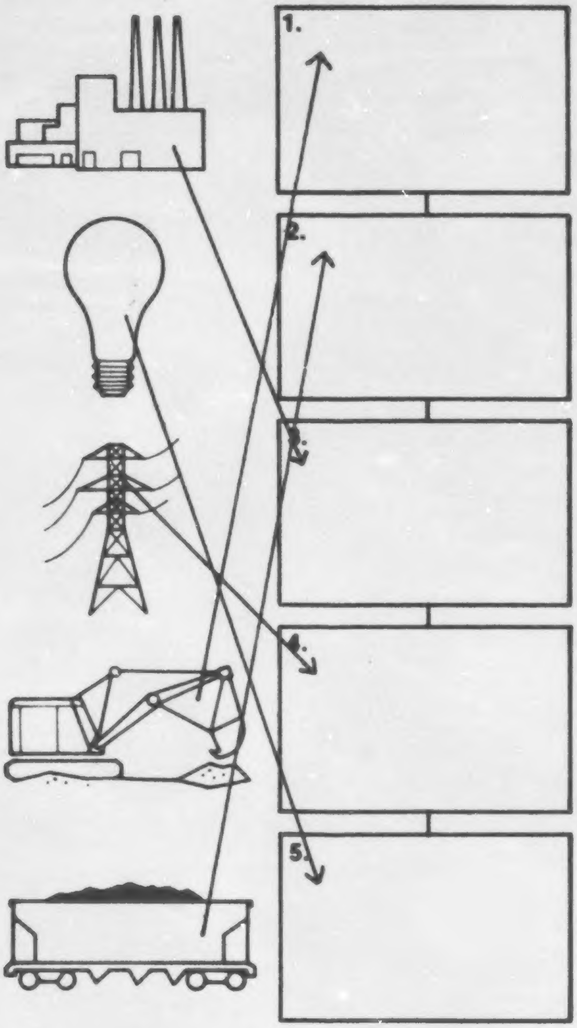
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Most of the problems can be solved, but the solutions that are devised will probably be expensive. Students should finish the study of coal with a clear understanding that there are choices to be made: between using less energy or paying increased energy costs; between having as much energy as possible or protecting the environment; and between sacrificing beautiful land and natural ecological systems or paying the cost (in higher energy prices) of having them restored. A balance must be negotiated between energy requirements and preservation of the environment.

Activity Master

How Coal is Used

This activity follows coal from the mine to your electric light.



1. Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted.
2. About 2/3 of our coal is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip.
3. 46 percent of U.S. electrical generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine, a series of wheels with vanes like a windmill. The turbine rotates coils of wire in a generator through a magnetic field to produce electricity.
4. Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.
5. Electricity lights the lamps in your home. How many other uses of electricity in your home can you name? Write them on the back of this paper. Then place a star before those you think you could do without.

Some Facts About Coal

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O — or both — in each blank. On the back of this sheet, write down ways some of the problems could be overcome. Compare ideas with your classmates.

O 1. 90 percent of U.S. fossil fuel reserves (coal, oil, natural gas) are coal.

P 2. Some deep mines are dangerous.

o/p 3. 50 percent of our mineable coal is in the western United States.

O 4. We have enough coal to last for 350 years, at current level of use.

P 5. Mining coal can cause damage to the environment.

O 6. In the future, we will rely more on coal as a source for synthetic oil and gas.

Activities 14 and 15*

NUCLEAR ENERGY

The first part of this lesson, (Activity Master 14) draws students' attention to the similarities and differences between a nuclear-powered and a fossil-fuel fired electric generating plant. Of special note is the vast difference in the amount of fuel necessary to generate the same amount of electricity, nuclear reactors being far more efficient.

Nuclear reactors, which have been operating safely in the United States for over 20 years, are fueled by uranium. Although the reactors use very little of the fuel compared with the amount of coal needed to produce similar amounts of electrical energy, uranium is a limited resource. Because of this, scientists are developing the breeder reactor, which actually produces additional nuclear fuel as it produces heat. If these reactors go into operation-scheduled now for demonstration in the 1980's and for commercial operation in the 1990's - we will be able to add substantially to our stockpile of nuclear fuel.

There are both benefits and risks associated with all energy use. Activity 15 shows how this is true of nuclear reactors. An important obstacle is the tremendous cost of developing and building breeder reactors. One risk is the large amount of plutonium, a by-product of uranium, that all reactors produce. In addition to being radioactive, plutonium is the raw material for atomic bombs and thus must be keep isolated and protected from theft.

Of course, any device capable of this much potential power is bound to be controversial. Some people feel that use of the nuclear reactor involves just too many risks. Others insist that all energy sources involve risk from pollution-related health effects or environmental disruption. Nuclear power risks, which have been studied in detail, have been calculated to be far smaller than many day to day risks our society now faces. Not using nuclear power could mean losing a valuable and necessary energy source. Nuclear energy is a very technical and complex subject and has been simplified in these pages. It is important that your students know some of the pros and cons concerning nuclear power so that as more information becomes available to them through the years, they will be able to make wise decisions concerning their energy future.

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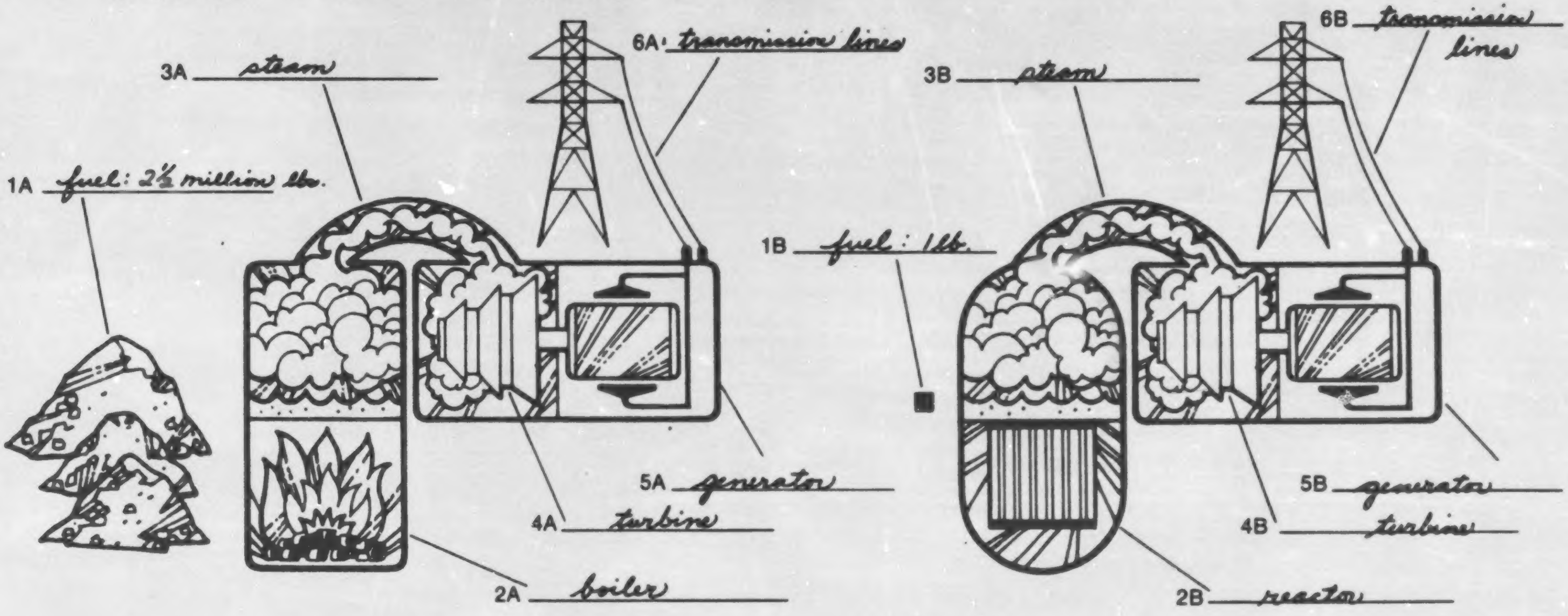
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

Activity Master

Nuclear Energy (PART 1)

One of the energy resources being considered to supplement our limited oil and natural gas supplies is nuclear power, created by the splitting apart of atoms of uranium. This power can be captured and used to create steam which produces electricity much as the power of burning coal is used in an electric generating plant.

The diagrams below show two kinds of electric power plants. They are much alike except that one is powered by nuclear energy produced in a nuclear reactor. Can you label the parts of the two plants. All the words you need appear at the bottom of the page. An encyclopedia or other reference book may help you.


3A steam
1A fuel: 2½ million lbs.
6A: transmission lines
5A generator
4A turbine
2A boiler
1B fuel: 1 lb.
3B steam
6B transmission lines
5B generator
4B turbine
2B reactor

A Fossil Fuel Electric Generating Plant

B Nuclear-Powered Electric Generating Plant

FOSSIL FUEL ELECTRIC GENERATING PLANT
NUCLEAR POWERED ELECTRIC GENERATING PLANT

GENERATOR
BOILER
STEAM
TRANSMISSION LINES

TURBINE
TRANSMISSION LINES
FUEL (1 lb.)
TURBINE

STEAM
REACTOR
GENERATOR
FUEL (2½ million lbs.)

Activity Master

Nuclear Energy (PART 2)

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in bold type. Read the list and put a (B) in the blank if it is a benefit, a (P), if it is a problem.

B LESS NEED FOR MINING AND **TRANSPORT** OF FUEL

B NO **POLLUTANTS** FROM BURNING FUEL

B LESS RELIANCE ON **IMPORTED FUEL**

P COULD BE TARGETS FOR **TERRORISTS**

B REACTORS PRODUCE **LESS WASTE** THAN FOSSIL FUEL PLANTS DO

B OVERALL **COST** OF ELECTRICITY WILL BE LESS THAN WITH FOSSIL FUELS

P HIGHER **COST TO BUILD**

P LARGE AMOUNTS OF **PLUTONIUM** COULD LEAD TO SPREAD OF NUCLEAR WEAPONS

P POSSIBILITY OF **RADIATION ESCAPING**

P **RADIOACTIVE WASTE** MUST BE HANDLED AND DISPOSED OF SAFELY FOR THOUSANDS OF YEARS

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) expansion of nuclear energy. Complete the arguments by inserting a KEY WORD (above) into the blanks for each problem area.

PRO: The radioactive waste is made into a type of glass or ceramic, put into special containers, and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the radioactive waste to lose its radioactive properties. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by radiation escaping

CON: There's always a chance that an accident or mechanical malfunction could present the danger of radiation escaping

PRO: Regulations and safeguards can be strictly enforced to keep the plutonium out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive plutonium is enough to make an atom bomb.

Lesson No. 8: Pollution and the environment
Behavioral Objectives: 16, 17
Time: 1 hr.

I. Review
    A. Questions
    B. Discussion

II. What is pollution?
    A. Two types
        1. Atmospheric
        2. Non-atmospheric
    B. Smog formation
        1. Formed during a precise ecological condition
        2. Burned fuels produce oxides of nitrogen
            a. Warm layer of air contains oxides
            b. Called smaze
            c. Happens only on overcast days
        3. Photochemical smog
            a. Only in the presence of direct sunlight
            b. Sunlight and nitric oxides combine with other particles in the air such as dust and unburned carbon-exhaust

III. Non-atmospheric pollutants
    A. Noise
        1. Stimulate
        2. Depress
    B. Dust
        1. Dust storms
    C. Thermal
        1. Least noticed but most devastating
        2. Can cause a disturbance in the weather
        3. Accelerate algae growth
        4. Kill fish
        5. Nuclear generator plant raises temperature approximately 50°+

IV. Environment
    A. Are we willing to destroy our environment to let progress in the field of energy continue?

V. Summary

A. Assignment: Alternative Sources of Energy.

Choose at least five of the alternate sources of energy and write a short paragraph on each.

References B1, M1, M2

Activities 16 and 17*

A DELICATE BALANCE (PARTS 1 AND 2)

Ask students to consider their own classroom environment by naming some of the living (other students, teacher, plants) and non-living (desks, air, blackboard) aspects of it. You may want to suggest more subtle aspects of the environment such as light and temperature as non-living factors.

List these factors on the board and discuss how they interact with each other, drawing arrows to illustrate the connections. For example, what happens when one student opens the window, makes noise, turns over a chair, spills water, raises the thermostat - how does it affect other students, the teacher, the plants? Which of these activities might be considered disruptive or "polluting?"

After learning the idea of environment and its interlocking relationships, students can apply these concepts to the activity on Activity Masters 16 and 17. You may want to point out that some pollutants, such as radioactivity, cannot be seen in the picture, but in fact, may be present. Do not overlook that people and animals pollute, with dumped sewage and farm run-off, for instance. Discuss energy sources that do not pollute.

Encourage students to weigh cost "trade-offs" when considering environmental controls. We must achieve a reasonable balance between the development of energy resources and the preservation of the environment. There may be costly disruption of western lands in developing new coal resources, for instance; but is it more costly in possible loss of resources not to mine in the West? Activity 17 outlines measures that are already being practiced to protect the environment and to control pollution. Students are asked to weigh their part in meeting the cost.

After students have completed the worksheets, you may want to discuss with them which parts of the picture compose the living and non-living environment, which kinds of pollution are chemical and which are physical. Students can also discuss how parts of the scene - the city air and the plants and animals in the country, for instance - affect one another.

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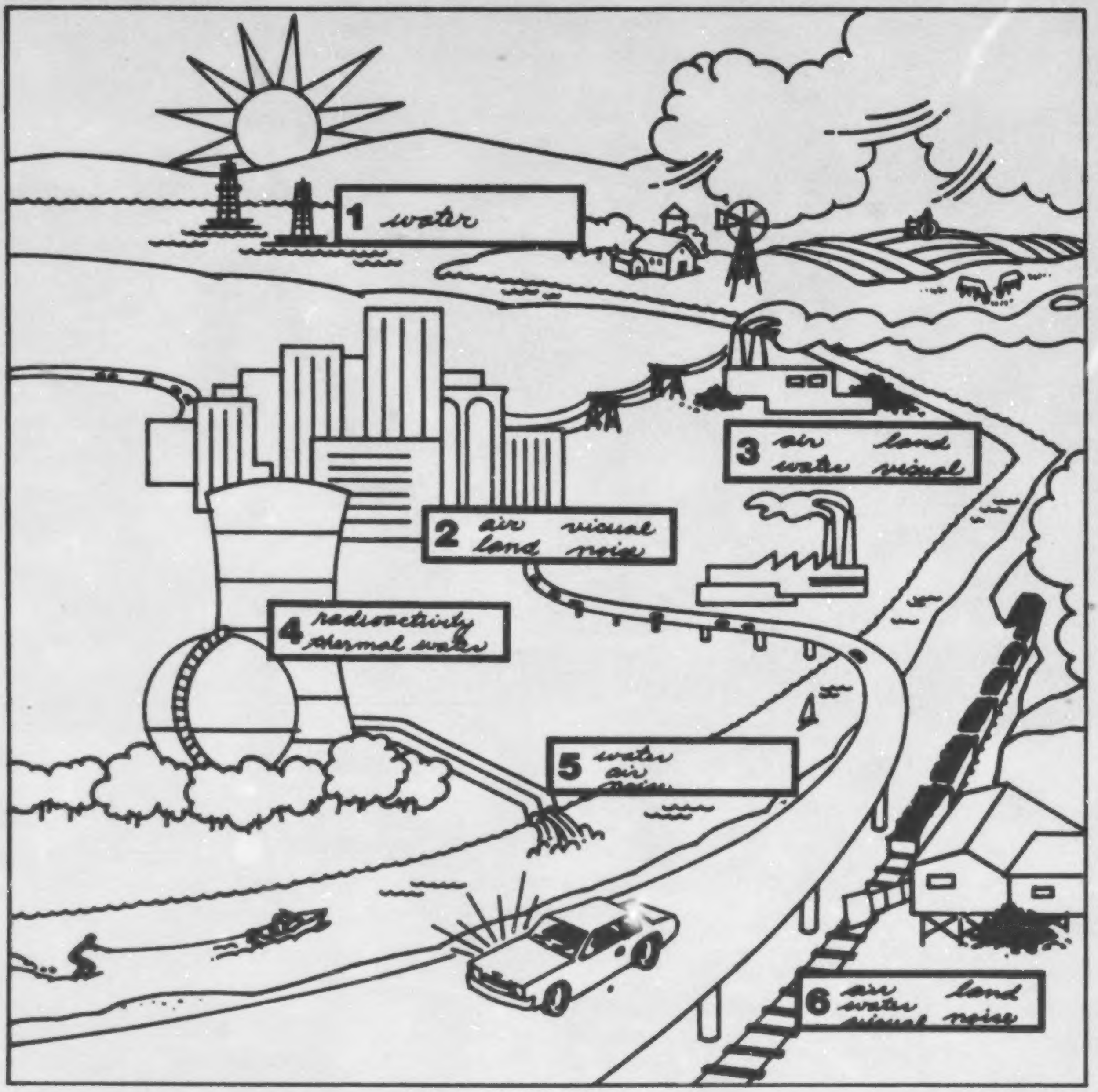
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

A Delicate Balance (PART 1)

Activity Master


1 water
2 air visual
land noise
3 air land
water visual
4 radioactivity
thermal water
5 water
air
noise
6 air land
water
visual noise

1. Name the possible sources for energy in the picture. sun, wind, coal, oil, nuclear reaction

2. What energy sources shown are used to generate electricity? coal, nuclear reaction

3. Seven types of environmental pollution concern us today: air, water, thermal (heat), radioactivity, visual, noise, and land disruption. In the boxes on the picture above, write in the type of possible pollution occurring in that part of the picture.

4. How do different parts of your environment—air, water, land, people, city, country—affect each other?

5. To help keep that delicate balance between meeting our energy needs and maintaining a clean and healthy environment, what in your life would you be willing to change?

Activity Master

A Delicate Balance

(Part 2)

From the clues given on the chart below, identify each type of pollution: water, air, or land disruption. In the last column of the chart, place the number of the choice listed here that you agree with.

1. "I know I will have to spend more dollars to pay for electricity, fuel, gasoline, and other energy-related products so that energy producers can pay for environmental controls."
2. "I will cut back on my own energy use — really practice conservation."
3. "I will support more government regulations."
4. "I can count on business and industry to find the answers."
5. "I'm willing to live with pollution."
6. If you can think of other solutions, write them down.

TYPE OF POLLUTION	WHAT IS IT?	WHAT CAN IT DO?	HOW CAN IT BE IMPROVED?	WHAT WOULD I BE WILLING TO DO?
air	It is the adverse effect from burning coal and oil, and from car exhausts. It is high concentrations of carbon monoxide, sulfur dioxide, and unburned ash.	It can increase respiratory illnesses and raise death rates. It can damage crops, plants, and trees.	By installing emission controls on autos and filters or traps on chimneys. By cutting down on the burning of coal and oil. By burning solid wastes in closed incinerators. By capturing and reusing industrial gases for other products.	
land disruption	It is the use of millions of acres for mining, development of power plants, refineries, transmission lines, energy-resource storage, and solid waste disposal.	It can disturb wilderness and recreation areas. It can destroy vital plant-animal food chains and can cause erosion and loss of soil nutrients.	By reclaiming mine sites. By landfilling and recycling solid wastes. By replanting vegetation, reforesting, building lakes and recreational parks.	
water	It is high amounts of impurities such as disease-causing organic wastes, toxic substances such as acids and pesticides. It can be caused by oil spillage, offshore construction, industrial waste, and municipal sewage.	It can disturb or destroy fish breeding and feeding grounds, can cause taste and odor problems, clog streams, destroy recreation areas and sometimes cause disease in humans. Mines can contaminate ground water.	By installing filters, aeration and settling devices. By breaking down impurities with chemicals. By cleaning up rivers and shorelines. By transforming acid wastes to useful by-products.	

THINK ABOUT IT: Make a list of things you can do today to help stop pollution.
Start with these: Don't litter. Recycle. Use public transportation. Don't burn rubbish or leaves. Can you add to the list?

Lesson No. 9: Alternate Sources of Energy
Behavioral Objective: 18
Time: 2 hrs.

I. Review
  A. Questions
  B. Reminder of assignment on pollution due tomorrow

II. Alternate energies
  A. Developed from the fuel shortage
  B. Developing technology
  C. Extremely important in the future
    1. Careers!

III. Basic alternate sources
  A. Solar
  B. Wind
  C. Geothermal
  D. Gravitational
  E. Methanol
  F. Hydrogen and Alcohol (Fuel cells)

IV. Solar
  A. The sun is the source of all energy
  B. It produces enough energy in two days to equal the amount we'd get by burning all oir remaining oil, gas, and coal
  C. Utilized years ago
    1. 1878 Worlds Fair in Paris
    2. Utilized by farmers in drying crops
  D. Catagories
    1. Photovoltaic cells
      a. Works on a chemical reaction to product electricity
      b. Utilized in space
      c. Expensive
      d. Inefficient-10-25%
    2. Collector panels
      a. Liquid
        i. Utilizes the suns rays to heat the liquid inside the panels

81

            ii. No problems with freeze-up in the winter

    3. Basic cost
        a. Range from $4 to $7 per sq. foot
        b. Whole panels range from $144 to $600
        c. Cost of controls range from $700 to $900
            i. Includes storage
        d. Total system costs between 2 1/2 to 3 times a conventional heating
        e. Cost is beginning to descend as the panels are going into mass production and the price of oil and gas continue to rise
        f. Must be careful of fraud

E. Materials
    1. Aluminum
        a. Corrodes easily unless coated
    2. Steel
        a. Corrodes easily unless heavy
    3. Copper
        a. Costly but conducts heat well

V. Wind
A. Development of an ancient technology
    1. Used for pumping water and grinding grain
B. Winds vary from place to place and speeds are irregular
C. Small scale generation has been tested throughout the country
    1. Is feasible in remote areas
    2. Is feasible in areas that have winds on the average of 7 mph +.
    3. Units are still costly and require substantial capital layouts
    4. More experimentation is needed
D. Large scale neneration is being studied and done
    1. Problems
        a. Cost
        b. Blade angles or pitch
        c. Height of construction necessary to fully utilize the winds

- d. Non-constant production of electricity
  - i. Storage is a big problem
  - ii. Uses low discharge batteries

VI. Geothermal

- A. Tapping the earths' energy
  - 1. Inside the earth are reservoirs of hot brine or hot steam
  - 2. Utilize this energy to run turbines
- B. A natural steam field in California could now satisfy more than 40% of the electrical needs of a city the size of San Francisco
- C. Problems
  - 1. Inefficient conversion
  - 2. There are few natural steam fields in the U.S.
  - 3. Cost
  - 4. Turbines tend to deteriorate more quickly because of the brine solutions compostion

VII. Gravitational

- A. Utilizes the rotation of the earth to produce energy
- B. Basically it is using the tides
  - 1. When the tides come in they are stored in a container such as a dam. When the energy is needed the water is let to flow out passing through turbines that run generators.
- C. Also a device can be put out to sea that converts the "bobing" of the waves through a mechanical device into a usable energy
- D. Problems
  - 1. Costly and still very experimental
  - 2. Geographical locations

VIII. Methanol

- A. A gas that is made from municipal wastes through the process of anerobic digestion
  - 1. As the wastes decay the bacterial actions produce a gas that can be burned
- B. Advantages
  - 1. It can be easily stored
  - 2. Does not cause dieseling or back firing if used by automobiles
  - 3. Non-polluting

        4. Wastes can be obtained almost anywhere
        5. The bi-product is usable as a manure
    C. Dis-advantages
        1. It is extremely high octane
            a. Octance rating of 120+
            b. Highly flamable when mixed in proper proportions of air
        2. Can supply only a limited amount of energy

IX. Hydrogen and Alcohol
    A. Hydrogen
        1. Can be produced from water
            a. Burns cleanly
        2. Costs are high to produce
        3. Storage and transportation problems
        4. Hydrogen can be converted into methanol
    B. Alcohol
        1. Burns clean
        2. Expensive to produce
        3. Non-polluting

X. Others
    A. Temperature gradiant of the sea
    B. Fuel cells
    C. Magnetohydrodynamic
        1. Pulverizin coal under a tremendous temperature and passing it through a magnetic field to cause and EMF to result

IX. Summary

References B1-6, M1-4

Activity Master 18*

LET'S POWER SPACESHIP EARTH WITH THE SUN!

The sun, as the "mother star" of our solar system, is the source of almost limitless energy. The sun's energy is "thermonuclear" in origin. The sun's core is so hot that a nuclear reaction takes place releasing tremendous amounts of energy into space in the form of rays or waves of radiation. Visible light, heat, and radio waves pass through the earth's atmosphere in just the right amound necessary to sustain life on the planet. The outer ozone layer of the atmosphere, created by the sun's action on oxygen molecules, acts as a protective layer against lethal solar radiation.

You can demonstrate the rays of visible light waves by shining a beam of sunlight through a prism or even a drinking glass full of water. The seemingly yellow-white light will break up into rays of violet, blue, green, yellow, orange, and red. Remind students that they have seen these light rays in a rainbow.

The sun heats the land and the oceans, creates the great currents, the wind and the waves. It evaporates water, providing the energy for the important water cycle on earth. The water that falls as rain feeds the rivers and the streams that turn water wheels and turbines of hydroelectric plants. Radiant energy is changed to stored chemical energy by the process of photosynthesis that takes place in the cells of green plants. It is this chemical or potential energy that is stored in coal, oil, and natural gas.

After working on this activity sheet students can better place our reliance on the energy of the sun in both a natural and an historical context. Students identify a list of things as direct or indirect products of the sun's energy. Several discussion questions permit the class to imagine a life in the future powered by a major non-polluting, inexhaustible energy source. Students might consider that while solar energy as a major energy source is very attractive, the cost of developing the technologies on a commercial scale is great.

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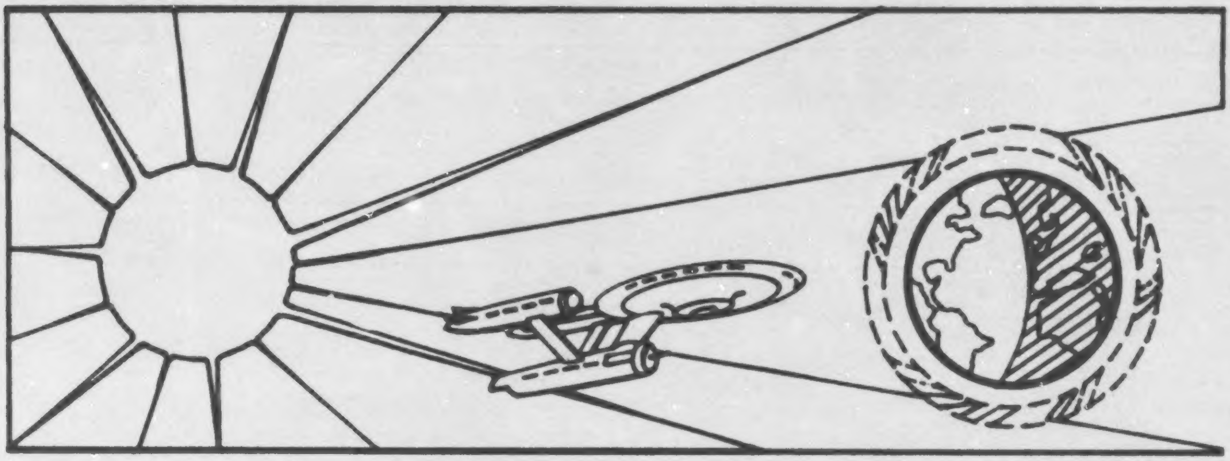
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.



Let's Power Spaceship Earth With the Sun

The sun, 93 million miles away from earth, sends more radiant energy toward us every second than people have used in the course of human history. Thirty percent of this energy is reflected back into space by our atmosphere. Much of the remaining radiant energy of the sun heats the land and the water; it evaporates water and melts the snows. It is the source of energy that creates the winds and great ocean currents, and it warms the atmosphere that surrounds us.

Energy from the sun interacts with oxygen at the top of the earth's atmosphere to create a layer of ozone that protects us from lethal amounts of the sun's radiation. Solar energy reacts with plants in the chemical process of photosynthesis to provide the stored energy that fuels life. Coal and oil and natural gas, once swamp jungles of the ancient earth, are stored solar energy. All of these are ways we benefit from the sun's energy directly.

We also benefit indirectly from the sun's energy when that energy comes to us "secondhand." The electricity generated by a windmill, for example, is the sun's energy once removed. So, too, is the energy our bodies get from the food we eat.

Less than one percent of the incoming solar energy is used to sustain plant and animal life, yet this amount is many times greater than the total electric generating capacity of the entire world. the sun could be an important answer to our energy dilemma. All we have to do is find the key to the bank.

Humans from the dawn of history have put the energy from the sun to work to keep warm or to grow food, or by harnessing the wind. In what ways did early people use the sun to do work for them?

What has the energy from the sun made possible in your life today?

Put a D beside each of the following things that result from energy received directly from the sun. Put an I beside each thing that results indirectly from the sun's energy.

D **coal deposits**

I **sailboats**

D **salt flats**

I **gasoline**

D **photosynthesis**

D **mountain streams**

I **Hoover Dam**

D **sugar cane**

I **candy bar**

I **electric heater**

D **leaves turning green**

D **ocean currents**

I **steam engine**

D **ozone layer of the atmosphere**

THINK ABOUT IT:

1. Why is the sun called the source of all energy except nuclear?
2. Imagine life on earth in the future if we learn to harness the power of the sun to provide heat, light, and electricity. What problems would be solved? What problems might be created?

Activity Masters 19 and 20*

ENERGY FROM THE SUN

The activity sheets introduce only two of the technologies of solar energy. Actually there are now six solar energy conversion systems being studied. To attempt to treat all six on two sheets would not be productive for most students. In addition, understanding of all these methods demands a technological background that most of your students will lack. A brief description of each one follows:

1. Solar Heating and Cooling of Buildings. The technology includes space heating, space cooling, and solar water heating. The illustration on Activity Master 19 demonstrates one type of roof collector. One of the great advantages of this method, of course, is that each building would have its own collection system, independent of a municipal system. Though expensive to install, these systems have an almost negligible maintenance and operating cost.

2. Activity Master 20 shows a sketch of a Photovoltaic Electric Power System, or solar cell. When light rays from the sun strike the thin silicon chips in a solar cell, an electric current is produced. The process requires no equipment that will wear out, does not pollute, and has unlimited life expectancy. The immediate obstacle to the widespread use of solar cells as an energy source is twofold: the energy-conversion efficiency of the cell is low-less than 20 percent; and the cost of necessary technological development in order to mass produce the cells is extremely high.

3. Solar Thermal Conversion. This system consists of solar collectors and thermal storage devices delivering high-temperature thermal energy to a turbine power plant. A solar "farm" would be made up of many collectors that have curved surfaces so that they can concentrate the sun's rays and focus them at one point to create very high temperatures. That "one point" may be a pipe containing water or some other liquid. The intense heat will turn the liquid into a gas, which can then power a turbine.

4. Wind Energy Conversion. Wind energy is a secondary form of solar energy derived from heating of the earth by the sun.

5. Bioconversion to Fuels. The Bioconversion to Fuels (BCF) involves the use of the sun to grow plants which may then be converted to clean, burnable fuels.

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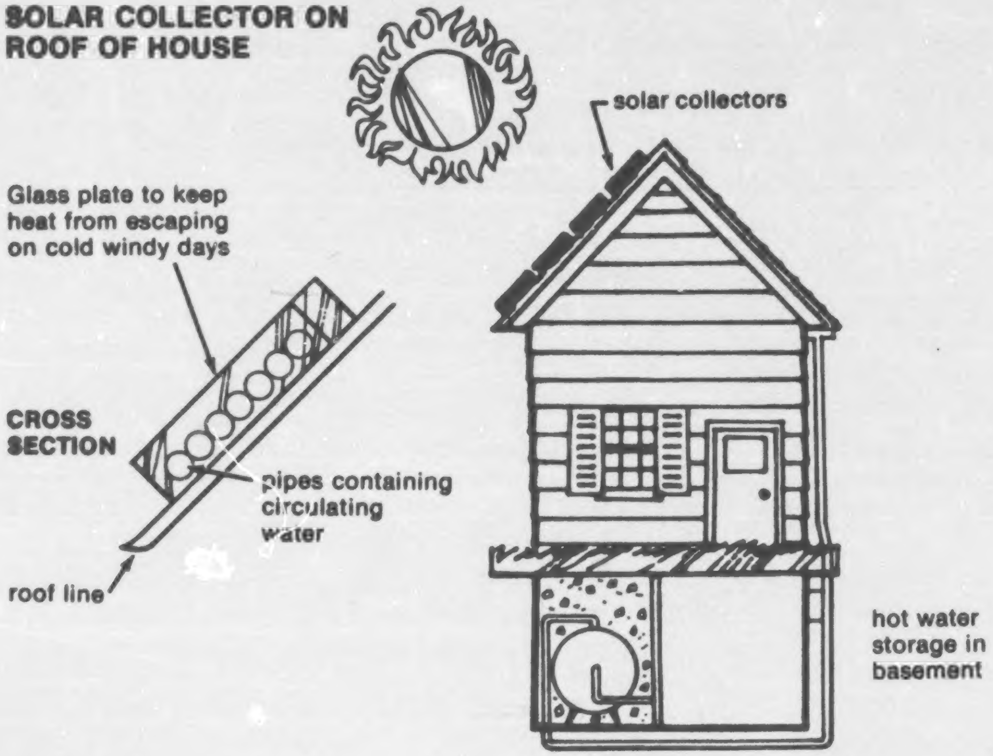
*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

6. Ocean Thermal Conversion power plants will take solar-heated water from the upper level of the ocean and use this heat to turn a liquid with a low boiling point into a gas to drive a turbine. Then, cold water is brought up from a lower ocean level via a pipe to condense the gas, and the process is repeated.

Activity Master

Energy from the Sun (Part 1)

There are several ways to use solar (sun) energy. One way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning, and water heating, but not its electric power. Another is to build huge solar farms to collect solar energy, turn it into heat and then to electricity that will be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.


SOLAR COLLECTOR ON ROOF OF HOUSE
solar collectors
Glass plate to keep heat from escaping on cold windy days
CROSS SECTION
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?
the South; Southwest

2. What side of the roof should the collectors be mounted on?
the south side

3. Why is the inside of some types of collectors lined with mirrors?
to reflect and concentrate the rays of the sun.

4. Will the heat from roof collectors be used to generate electicity?
No

5. Could the heat from solar farm collectors be used to generate electricity?
Yes

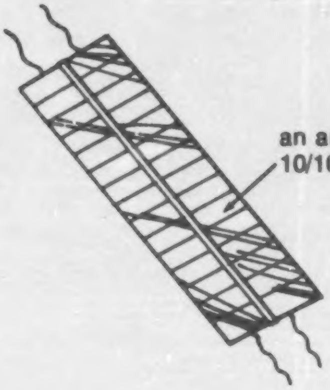
6. The U.S. Energy Research and Development Administration foresees as much as 25 percent of our energy needs filled by solar technologies by the year 2020. Why will it take so long?
technology; cost; setting research priorities

Activity Master

Energy from the Sun (Part 2)

SOLAR CELL

This device converts sunlight directly into electricity, with no moving parts and no pollution.



an array of thin silicon cells 10/1000 in. thick

wires lead to electrical batteries which power lights and motor-driven appliances.

1. Solar cell systems are now used to power spaceships and satellites

2. We probably will never run out of silicone as a resource because it is the second most plentiful substance on earth. Do you know its more common name? sand

3. If it now costs $20 a watt to generate electricity by means of solar cells, how much would you have to spend on equipment to power just the 100 watt light bulbs in your house? # of bulbs × 100 × $20

4. What do we need to do before we can use solar cells as an energy source? further develop technology and bring down cost

5. How can electricity be stored to use later? in storage batteries

THE ADVANTAGES AND THE DISADVANTAGES OF SOLAR ENERGY

DISADVANTAGES

1. Expensive to install
2. Requires a great deal of space
3. The sun doesn't always shine
4. Would mean modification of housing in many cases
5. New laws would be needed concerning construction that might cast shadows

ADVANTAGES

(See if you can supply the advantages. What is good about solar energy in regard to each of the following?)

1. Supply. The sun's energy is almost inexhaustable
2. Pollution. Solar energy is clean; no mining or burning.
3. Embargoes. No nation can cut off another nations supply of sunlight.
4. Cost. Installations are inexpensive to maintain.

Activities 21 and 22*

OTHER NEW ENERGY RESOURCES

Ask students to read Activity 21, which offers a quick summary of several new energy sources. To complete Activity 22, they will need to refer to this information, to the other activities in the unit, or to other available information. The student may sometimes have to make a value judgment. If the student's answer doesn't correspond to the answer shown on the master, ask if the student can defend his or her answer with a valid explanation - a good way to stimulate classroom discussion.

After students finish filling in the blanks and after you have discussed their answers, you might want to find the energy sources with the fewest problems and the most benefits. Numbers of problems and numbers of benefits are not always conclusive, however. One problem might be so severe that it outweighs all the benefits. Ask students which sources of energy seem more likely to work than others? Which of them - if any - might fill our energy requirements of the future? This activity, and the discussion that follows, will help to demonstrate that our energy needs may be ultimately filled not by a single source, but a practical combination of many.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

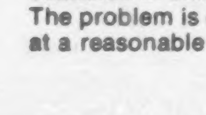
Activity Master

Other New Energy Resources

Besides nuclear and solar energy, there are several other possibilities for the future. Read about some of these new energy sources on this page. Problems and solutions are associated with each of them. On the next page you will decide what some of these problems and solutions are.

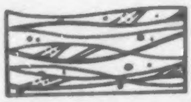
WIND. Wind is actually a form of solar energy since it is caused by variations in the temperature of the air heated by the sun that causes air to move. Sailors used this energy for ages. For many years farms have used windmills to generate electricity. Maybe giant windmills will someday be able to provide electricity for entire towns. The major difficulties are that the wind doesn't blow all the time and that practical storage systems are still being developed.

GEOTHERMAL. The earth's center is a molten mass. In some areas this mass is close to the surface. Some evidence of this are volcanos, geysers, and hot springs. This heat can be trapped and used to generate electricity to supply cities without polluting the atmosphere. The problem is that this energy can now be tapped only where it is near the surface. Scientists are searching for other areas where this geothermal energy can be reached, but they don't have all the answers yet.



PYROLYSIS OF SOLID WASTE. It is possible to heat waste in an oxygen-free atmosphere and produce oil and gaseous products. This waste is what we're now having trouble removing from our environment: manure, garbage, paper, logging residue, some industrial waste, sewage, and the like. The difficulty is that this material tends to be scattered in small amounts at various sites. The problem is one of gathering it together at a reasonable cost.

COAL GASIFICATION. By using high temperature and pressure, coal can be converted into a gas very much like natural gas. Building these conversion plants near coal fields can solve the problem of transporting bulky fuel that gives off pollutants when it is burned. When coal gas is burned, it burns as cleanly as natural gas, causing virtually no air pollution. The usual pollution problems occur in the coal mining process, however, as they always have. The conversion process itself, however, uses large amounts of electrical energy.



COAL LIQUEFACTION. Although the technology is not completely developed, coal can be converted to an oil-like liquid. It has the advantage over coal gas of being usable to make all the usual oil products, including a kind of gasoline to run our cars.

OIL SHALE. Oil shale is a rock containing a material that yields oil when it is crushed and heated. One ton of rock will produce about 25 gallons of oil. Most oil shale deposits are in the West. The rock must be mined, either by deep mining or surface mining. Extracting the oil takes large amounts of water — three barrels to every one barrel of oil processed. One of the big problems is the disposal of the spent rock after the oil is extracted. Vegetation will not grow on the used shale without a moderate amount of rain — scarce in many parts of the West. Without vegetation, some animals may lose their homes and natural food supply. Rain water passing through this rock will possibly pick up pollutants and carry them to larger bodies of water if there is no vegetation. In addition, oil shale processing contributes to air pollution.

Problems/Solutions

In this unit, you have learned about eight new energy resources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues — some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

	IF THIS ENERGY SOURCE IS USED, IT . . .	SOLAR	NUCLEAR	WIND	GEO-THERMAL	COAL GASIFICATION	COAL LIQUIFACTION	OIL SHALE	PYROLYSIS
S	WOULD HELP SOLVE THE PROBLEM OF SOLID WASTE DISPOSAL.	✓		✓	✓	✓	✓		✓
P	COULD POLLUTE WATER.		✓		✓			✓	
S	WOULD CONSERVE THE DWINDLING RESERVES OF FOSSIL FUELS.	✓	✓	✓	✓				
P	COULD DAMAGE WILDLIFE OR THEIR HABITAT.				✓			✓	
P	WOULD BE DIFFICULT TO STORE AND TRANSPORT.	✓		✓					
S	WOULD NOT POLLUTE THE ATMOSPHERE.	✓		✓					✓
P	WOULD DISRUPT THE NATURAL USE OF LAND SURFACES.		✓		✓	✓	✓	✓	
P	WOULD NOT BE ABLE TO SUPPLY ENERGY ALL THE TIME.	✓		✓					
P	WOULD HAVE TO WAIT UNTIL THE TECHNOLOGY IS DEVELOPED.	✓		✓	✓	✓	✓		
P	WOULD USE LOTS OF WATER TO PROCESS.							✓	
S	WILL DECREASE THE NEED FOR OIL IMPORTS.	✓	✓	✓	✓	✓	✓	✓	✓
P	WILL MAKE LARGE AMOUNTS OF WASTE MATERIAL.							✓	
S	WILL MAKE USE OF THIS COUNTRY'S MOST ABUNDANT FOSSIL FUEL					✓	✓		

Activity 23*

HIDDEN WORD REVIEW

The hidden word puzzle contains 30 words found in the activities of the program and on vocabulary lists. Your class members may enjoy competing to see who finds the most words. The answer to each of the review questions is a word from the puzzle.

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*The Energy Challenge, n.d., Federal Energy Administration, Washington, D.C.

T	R	A	I	N	C	E	M	B	A	R	G	O	P	G
E	N	V	I	R	O	N	M	E	N	T	A	L	R	E
L	U	M	E	I	N	S	T	E	I	N	S	I	I	O
E	C	A	P	D	S	R	O	Y	B	L	O	F	M	T
C	L	U	S	Y	E	P	L	L	U	T	M	E	A	H
T	E	I	U	M	R	M	E	R	A	M	U	S	R	E
R	A	N	P	B	V	O	A	C	A	R	S	T	Y	R
I	R	S	P	A	A	Z	L	N	E	R	N	Y	E	M
C	L	U	L	W	T	R	L	Y	D	O	I	L	C	A
I	O	L	Y	I	I	E	R	A	S	B	C	E	L	L
T	W	A	T	T	O	N	B	E	Y	I	P	R	O	S
Y	A	T	I	L	N	I	D	E	L	O	S	E	A	M
B	O	E	G	A	S	I	F	I	C	A	T	I	O	N
B	P	O	P	U	L	A	T	I	O	N	L	I	H	P
S	E	C	O	N	D	A	R	Y	E	N	E	R	G	Y

Activity Master

Hidden Word Review

Hidden in the diagram are energy-related words that you have met throughout *The Energy Challenge* activity program. There are 30 words altogether. Try to find as many as you can and circle them across, down, or diagonally. The letters of each word are always in sequence. You can answer the questions on this page with words from the puzzle.

1. In 1776, James Watt put the steam engine to work and started an energy revolution.

2. Albert Einstein prepared the way for the atomic age in 1905.

3. The three fossil fuels are coal, oil, and gas.

4. About 65 percent of our coal supply is used to generate electricity.

5. A seam of coal is a layer of coal lying beneath the surface of the earth.

6. Electricity is not a primary energy source; it is a secondary source.

7. Oil is measured by the barrel, which is the same as 42 gallons.

8. Burning solid wastes at high temperatures without oxygen is called pyrolysis.

9. An almost inexhaustible source of energy that does not pollute, is inexpensive to maintain but costly to install is solar energy.

10. Sunlight can be captured using a solar cell to provide electric power to a building.

11. Being careful about the amount of energy we use, by practicing conservation, we can save valuable energy.

12. If you insulate your house you can keep the heat in in the winter and out in the summer.

13. Shipping freight by train rather than by truck is much more energy-efficient.

14. Coal gasification turns coal into a clean, easily transportable fuel that can be used like natural gas.

15. The Organization of Petroleum Exporting Countries is usually abbreviated OPEC.

16. As a result of the oil embargo in 1973, there was a shortage of gasoline and fuel oil.

17. One of the worst sources of pollution in the U.S. is cars without emission control devices.

18. Prices very often go up or down because of supply and demand.

19. More and more people in every country in the world means a population growth that will use more and more energy in the years to come.

20. We will have to reach a delicate balance between environmental concerns and our growing need for energy

ENERGY - A LIST OF RESOURCES

Here is an annotated bibliography of energy resources available for free or at a nominal cost. These make excellent resources for students and instructors. Prices may vary from those listed here.

Keyed References (in lessons):

Books (B)

1. Energy for Survival
2. Energy Primer
3. Design with Wind
4. Direct Use the Sun's Energy
5. Handbook of Homemade Power
6. Producing Your Own Power

Magazines and Journals (M)

1. Alternative Sources of Energy
2. Energy and Power Journal
3. Popular Mechanics
4. Popular Science

A LIST OF RESOURCES

BOOKS

Energy Primer
Portola Institute
588 Santa Cruz Avenue $5.50
Menlo Park, CA 94536

Covers experiments, manufacturers, and equipment. An excellent resource for designing and building energy systems. It also has a multitude of addresses.

Handbook of Homemade Power
Bantam Books
666 Fifth Avenue $1.95
New York, NY 10019

Covers several areas of energy and sources for additional information.

Producing Your Own Power
Vintage Books (Random House)
201 E. 50 Street $3.95
New York, NY 10022

Covers several areas of energy such as wind, solar, and wood. It also shows small scale designs for practical uses.

Last Whole Earth Catalog
The Whole Earth Epilog
The Co-Evolution Quarterly
Whole Earth Truck Store
588 Santa Cruz Avenue
Menlo Park, CA 94025

The first two books on the list are catalogs that contain energy materials such as wood stoves, solar heater, etc... The third listing is a continuing magazine/suppliment to the Whole Earth Catalog/Epilog. This is an interesting book to have.

Energy, Earth and Everyone by Medard Gabel
Straight Arrow Books
625 Third St. $4.95
San Francisco, CA 94107

This is an excellent resource that contains three sections of: Energy for the earth which contains look at what we have and future outlooks; Energy sources which discusses the sources and uses; Global Energy development which contains developmental strategies of solar, wind, etc.....

Future Energies by Roy Meador
Ann Arbor Science
P.O. Box 1425
Ann Arbor, MI 48106 $2.95

Porvides a summary of the future energy prospects for mankind, with emphasis on the most promising sources.

Energy and Man: Technical and Social Aspects of Energy by M. Granger Morgan
IEEE Press
345 East 47 St.
New York, NY 10017

Written for new students and professionals dealing with the technical and social aspects of energy. Contains chapters written by experts in their respective fields on such things as windmills, fuel cells, flywheel storage, etc..... Good reference book.

Fueling the Future: An environment and energy primer by Richard T. Sheahan
St. Martin Press, Inc.
175 Fifth Ave.
New York, NY 10010

Describes conventional and nuclear power plants, and explains the major environmental concerns and ways to control air, water and land pollution. Also the book assesses the present and the future in terms of energy.

350 Ways to Save Energy (and Money) in Your Home & Car By Henry R. Spies, Seichi Konzo, Jean Calvin, and Wayne Thomas.
Crown Publishers, Inc.
419 Park Ave. South
New York, NY 10016

A book on ways to conserve energy and save money in your home and with your car.

Solar Energy by John Hoke
Franklin Watts, Inc.
575 Lexington Ave
New York, NY 10022

Explains solar energy and its applications. Also contains activities and projects which may be done using solar energy.

Fuel Cells: Power for Tomorrow by D.S. Halacy, Jr.
The World Publishing Company
2231 West 110th St.
Cleveland, OH

This book gives the history, operation, application, construction of, and future of fuel cells.

Survival 2001: Scenarios From the Future by Henry E. Voegeli and John J. Tarrant
Van Nostrand Reinhold Co.
450 West 33rd St.
New York, NY 10001

This book is an effort to help the student understand what was happening back in history - what is being done now - and what can we look forward to in the future.

Design with the Wind By Douglas R. Coonley
Total Environmental Action
Church Hill $7.00
Harrisville, NH 03450

This book investigates the creative uses of the wind that are possible with proper building design.

Solar Energy and Shelter Design by Bruce Anderson
Total Environmental Action
Church Hill
Harrisville, NH 03450 $7.00

This book looks at basic issues underlying the need for the use of solar energy, discusses energy conservation, analyzes the ways of collecting and using solar energy, and concludes with a description of most past solar projects.

Direct Use of the Sun's Energy
Total Environmental Action
Church Hill
Harrisville, NH 03450 $1.95

A well documented discussion of the multiple uses of the sun's energy. Topics covered range from water heating and crop drying to heat engines and photovoltaic conversion.

Energy for Survival by Wilson Clark
Total Environmental Action
Church Hill
Harrisville, NH 03450

Widely acclaimed for its encyclopedic coverage of both the potential of the many alternative energy sources as well as the limits of the traditional ones.

The Energy-Environment Source Book

National Science Teachers Association
1742 Connecticut Ave., NW
Washington, DC 20009
$4.00

Examines the issues, problems, and facts of energy-environment-economic interactions.

Energy-Environment Materials Guide

National Science Teachers Association
1742 Connecticut Ave., NW
Washington, DC 20009
$2.00

A bibliography of authoritative and accessible energy literature.

Energy and Order

Friends of the Earth
529 Commercial St.
San Francisco, CA 94111
$3.00

A new approach to teaching energy, complete with lesson plans.

JOURNALS AND MAGAZINES

Alternate Sources of Energy

ASE
Route 2, Box 90A
Milaca, MN 56353
6 issues for $10.00 or 12 for $18.00

Covers many energy areas. Written for practical applications and contains additional references and sources of information. This magazine is strongly suggested.

Earthbeats

Communications Office
University of Wisconsin
Sea Grant College Program
1800 University Ave.
Madison, WI 53706
Free

This newspaper is based on stories from Earthwatch, a daily environmental radio program heard over most WI stations. This is really another down-to-earth newspaper that contains many interesting and current facts on energy.

Popular Mechanics
Popular Mechanics
Subscription Dept.
Box 646
New York, NY 10019

$5.97 for one year

This is an excellent magazine with usually several articles and projects in energy. Makes a good resource.

Popular Science
Popular Science
P.O. Box 2871
Boulder, CO 80302

$7.94 for one year

This magazine is usually found in almost all schools. For the past couple of years they have been printing articles on energy and power.

Energy and Power Journal
NECEP
P.O. Box 618
Concord, MA 01742

Subscription rate $8.00 per year
Membership $10.00 per year

The NECEP is a non-profit organization, chartered in Washington DC., for the purpose of developing a high level of civic literacy as to the energy and power scene. Strongly suggested Journal.

Earth Journal
Minnesota Geographic Society
P.O. Box 6181
Minnehana St.
Minneapolis, MN 55406

$3.00 for one year

A new journal containing interesting down-to-earth articles on energy and related subjects. It is published quarterly.

PAMPHLETS

What's Behind the Energy Crisis?
Ambassador College Press
P.O. Box 11
Pasedena, CA 91123

This is an excellent pamphlet for handout to the students or use in your reference library. It covers the energy crises, the world's crippling dependence on oil, and solutions to our energy problems.

Numerous pamphlets on energy
Technical Information Center
Energy Research and Development Administration
P.O. Box 62
Oak Ridge, TN 37830
Free in limited quantities

These are free pamphlets on such things as the energy crisis, solar energy, and other related information. Write and ask for a listing of all available information.

An Introduction to the use of wind by Douglas R. Coonley
Total Environmental Action
Church Hill
Harrisville, NH 03450
$2.00

Background and introduction - considerations in it use-methods-potential energy available types and sizing of equipment - costs-history-evaluated listings of 28 manufacturers and 7 plans-energy storage.

Technology for Society-Sources of Energy
Technology for Society
U.W. Stout
Menomonie, WI 54751
$12.00

There are numerous (around 10) pamphlets on areas such as coal, solar, geothermal, oil, wind, hydro, etc..... They contain the history of each source, its application and activities that can be done in classrooms. This is a highly suggested resource that should be purchased!

MOVIES, SLIDES, AND FILMSTRIPS

Energy-Use it Wisely Around the Home
Photographic Divisions
Office of Communication
U.S. Dept. of Agriculture
Washington, DC 20250
$18.50

A Slide/Tape series on energy conservation measures around the house.

Energy Sources BFA Educational Media
2211 Michigan Ave.
Santa Monica, CA 90404

Contains two parts each with 8 filmstrips and cassettes on energy sources.

Energy Films Catalog
Energy Research and Development Administration
Film Library
P.O. Box 62
Oak Ridge, TN 37830

This is a catalog of free loan films that can be obtained from ERDA. Most films are outdated, but there are some extremely good films that are current and great to use in the classroom.

OTHERS

Living with Energy
Standard Oil Company
Mail Code 3705
200 E. Randolph Dr.
Chicago, IL 60601

Free

This is a file of four spirit masters that emphasizes that Americans can no longer live with energy as they did in the past. Excellent handout for the students to emphasize their life style.

Energy Reporter
Federal Energy Administration
Energy Reporter Subscriptions
Room 2115
Washington, DC 20461

Free to officials of school systems with orders on a school letterhead.

An informative monthly report on energy activities in and out of government.

The Household Energy Game
University of Wisconsin Sea Grant Program
1800 University Ave.
Madison, WI 53706

Free

It is designed to show how the family is dependent of fossil fuels. By calculating how much energy the family uses, you will get an idea of how your household energy consumption compares to today's average American household, and where you might be able to conserve energy.

Anything and Everything
Technical Information Center
Energy Research and Development Administration
P.O. Box 62 Oak Ridge, TN 37830

Most of the information is free

This is a national clearinghouse for energy information. Write them and ask for whatever they have.

General Information
Your Local Power
and Light Company — Usually free

The local power company has much information on energy in the form of pamphlets, films, etc.....

ADDITIONAL ENERGY ACTIVITIES

What are some activities you can do in Energy? Here's a small list of hands on student activities for energy.

Construct a solar panel
Compare solar panel efficiencies
Construct a solar oven
Construct a solar cooker
Develop a solar heating system
Compare air vs water collectors
Compare various storage devices
Construct a model house using solar
Construct a solar still
Develop a solar concentrator
Use solar cells
Construct a solar powered vehicle
Construct a solar hot water heater
Construct a sundial
Measure the efficiency of solar cell
Reflectivity of different materials
Construct a parabolic reflector
Construct an electromagnetic crane
Measure the heat value (BTU's) of various types of wood
Construct an efficient wood stove
Experiment with oil shale
Construct model rockets (areodynamics experiment)
Devleop more efficient transportation systems
Construct a simple battery
Compare different efficiencies
Construct a methane generator
Experiment with a fuel cell
Develop a hydrogen car or other transportation device
Construct a device to convert the winds energy into a useable form of motion
Design and construct a device (Land, water, air) that could be used for vehicle transportation

Develop and construct various balde designs for wind generators

Research the feasibility of small scale and large scale wind generation for your locality

Construct a hot air balloon

Develop a transmission system to transmit the suns energy to earth

Learn about lasers

Construct a device to produce steam

Construct a steam engine

Construct a steam turbine

Construct a steam turbine to produce work or electricity

Construct a test instrument ot measure wind speed and direction

Construct a test instrument to measure the suns energy

Test the pollution standards of various conversion devices

Construct a vehicle using steam power

Construct a vehicle using human muscle power

Construct a model of a nuclear power plant

Research the pollution that a nuclear plant has

Demonstrate the chain reaction that takes place in a nuclear reaction

Other related publications
from the Wisconsin Vocational Studies Center

UNDERSTANDING SOLAR ENERGY SYSTEMS Keaton, Edington and Stephey

- A comprehensive seven unit instructional module with 23 transparency masters, behavioral objectives, glossary, unit assignments and tests, activities and references. 151 pages. $7.00

ENVIRONMENTAL EDUCATION Lambert, Strey and Kronebach

- A comprehensive bibliography covering such topics as General Environment Education, General Ecology, Natural Resources, Energy, Land Use, Pollution and others with an Appendix on Audiovisual Material Sources. 37 pages. $3.00

for further information contact:

WISCONSIN VOCATIONAL STUDIES CENTER
964 Educational Sciences Building
1025 West Johnson Street
University of Wisconsin-Madison
Madison, Wisconsin 53706
608-263-3696

Activity Masters

for use with

INTRODUCTION TO ENERGY

Instructional Modules

by

Fred Posthuma
Westfield High School

and

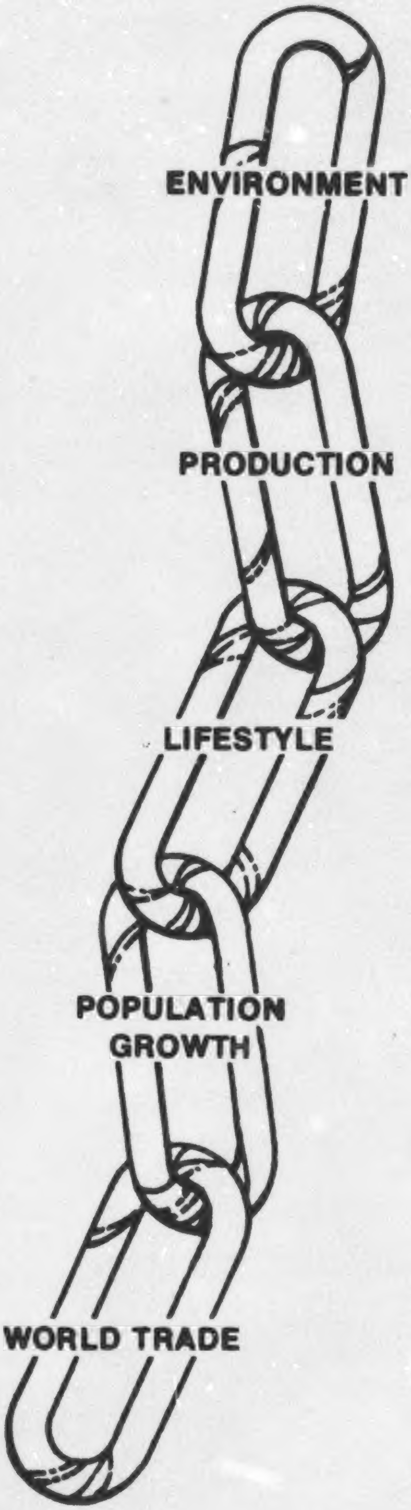
Merle Stephey
Wisconsin Vocational Studies Center

published by

Wisconsin Vocational Studies Center
964 Educational Sciences
1025 W. Johnson St.
University of Wisconsin-Madison
Madison, Wisconsin

Activity

The Energy Chain



Population growth, production of goods and services, dependency on foreign oil supplies, environmental health and safety, and the effect of these on our lifestyles — each of these is a link in the chain of energy use. Each is part of the energy challenge.

Draw a line from each short story to the appropriate link. Form small discussion groups. With others in your group, define the problem in the following situations and discuss what your solutions might be.

1. Time: One possible day in the future. Canada has decided to stop exporting oil. Some of the other oil-producing countries decide to band together and withhold oil in order to raise prices. U.S. supplies of oil are suddenly cut in half. There is no milk or bread in your house, no gas in the car, and you live 5 miles from the nearest store. What kinds of problems would you and your community face if there were a serious oil-shortage? How could you solve these problems?

2. Each year the number of students in your classroom increases. This means more seats in less space, more noise, less personal help from your teacher. A new business has opened in your town, employing 300 people. Suddenly, your class size has doubled. How will this affect you and your school?

3. A large utility company is planning to build an electric generating plant right where you and your family camp and fish every summer. The coal resources are nearby (mining hasn't started yet, though) and the city 500 miles away is desperately short of electric power. Should the plant be built? Why or why not?

4. Your uncle manages a large farm that produces many food products. He operates tractors and giant combines; he runs a gasoline-powered irrigation system, cow-milking machines and crop-drying equipment. He uses fertilizers made from petroleum. Because petroleum is scarce, his costs have more than doubled. If he cuts back on his use of petroleum-based products, he would seriously reduce food production per acre. Is there any way he can cut back on his reliance on petroleum? How can consumers help cut energy needs for food production?

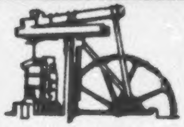
5. The annual operating budget of your city (your public tax money) can pay for either completion of the super highway system or enlarging the suburb-to-city mass transportation system, but not both. Most commuters don't like to ride buses, so the buses are usually only half full. The vote is coming up at the council meeting next week. How should the council vote?

Finish the Energy Timeline

Activity Master

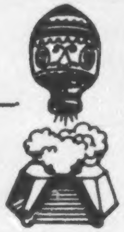
cut

1780 1785 1790 1795

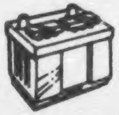


1776
In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is ______.

1783
Two men fly in a balloon at ____________
The energy used is
____



Most people burn wood for heating and cooking and travel by horse or on foot.

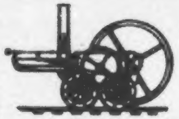


1800
In Italy, ____________ invents the battery and gives his name to the volt. The energy produced is ______.

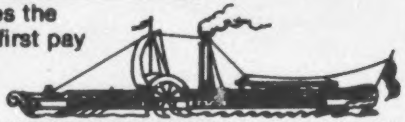
cut

1800 1805 1810 1815 1820 1825

1804
An Englishman, Richard ____________, puts James Watt's engine on wheels and rails. He is the father of the railroad locomotive.



1807
Robert Fulton doesn't build the very first ____________, but he makes the one people first pay to ride on.



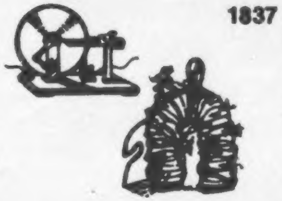
Wood continues to supply most household energy needs. But coal begins to do more in factories and railroad engines.

1821
First attempt to develop and market natural gas near Fredonia, N.Y.

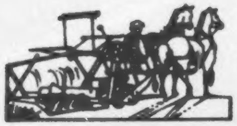
cut

1830 1835 1840 1845

1829 An American named
____
and an Englishman named ____________
each invents a generator.
Who is first? ____________
The energy produced?
____



1837 Americans put new inventions to work. First comes McCormick's ____________ then the steam shovel by ____________, and the telegraph by ____________.

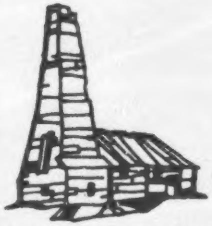


Railroads expand rapidly, hauling freight and passengers brave enough to stand the jolts and to risk hot cinders that often fly from the engine into their cars. England is first and America second in railroad locomotive production.

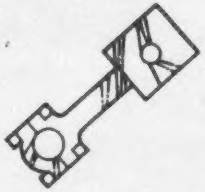
cut

1850 1855 1860 1865 1870 1875

1859
Edwin Drake strikes oil in Pennsylvania beginning the
____
industry.



1860
Lenoir of France invents the ____________ combustion engine.



An explosion inside a cylinder paves the way for the later invention of the automobile. An oil strike hastens the discovery of the fuel that will run it.

cut

·········· cut ··········

1880 1885 1890 1895

Coal and wood still furnish most of the energy in homes. Coal-fired "iron horses" (railroads) — and real horses — continue to take most people places. Although the electric bulb has been invented most people still use kerosene or gaslights to read by.

1884
In England, Charles Parsons perfects the steam ____________ and advances the development of electrical energy.

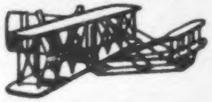
1886
Karl ____________ builds the 1st successful automobile.

1892
The oil-burning engine is invented by ____________
Eventually, this engine will replace steam-powered ones.

1895
The power of Niagara Fall is harnessed to make ____________

·········· cut ··········

1900 1905 1910 1915 1920 1925



1903
The engine in the Wright brothers' plane is powered by
____

1905 Albert Einstein develops a theory for measuring energy and prepares the way for the ____________ age.

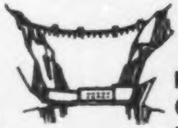
1910
Ford makes the first Model ____________ car.

By the end of this period, many new homes have coal furnaces in the basement. And more and more cars appear in garages.

·········· cut ··········

1930 1935 1940 1945

1926
Robert Goddard tests a ____________



1936
Hoover Dam on the Colorado River is built to generate
____
power.

1940

____________, a fiber made from oil, coal, and water makes its first public appearance.

1942
In Chicago, Enrico Fermi sets off the first
____
chain reaction.

Many homes convert from coal to natural gas for heating. Most families own at least one car and some have two.

·········· cut ··········

1950 1955 1960 1965 1970 1975

1952
Bell scientists raise hope for our energy future with the
____
battery.

1957
The U.S. gets its first big
____
electric power plant at Shippingport, Pa.

Demands for energy grow. America gets more people, more homes, more factories and businesses, more cars, more trucks, more buses, more planes. Demand grows faster than supply.

1970
Congress passes the
____
Air Act.

1973
OPEC nations
____
oil and produce an energy crisis.

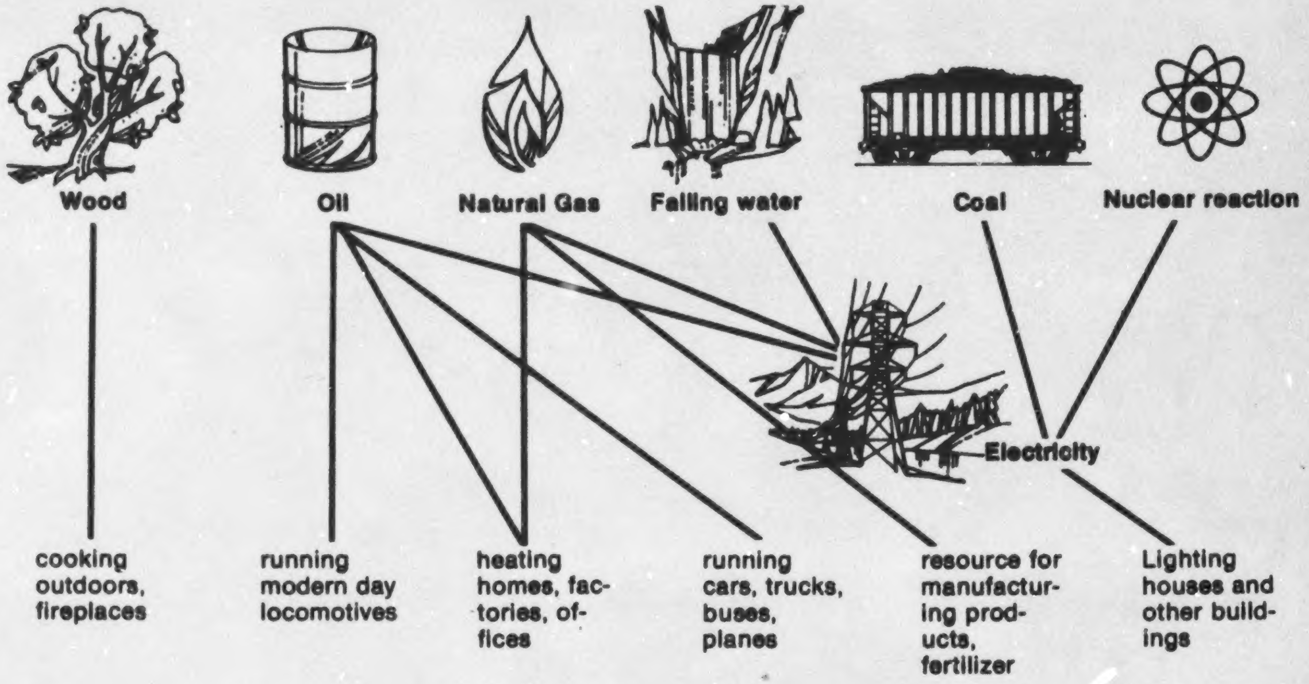
1976 Americans continue to look for ways to
____
the energy we have and find new ____________ sources.

·········· cut ··········

112

Activity

Primary Energy Sources


Wood
Oil
Natural Gas
Falling water
Coal
Nuclear reaction
Electricity
cooking outdoors, fireplaces
running modern day locomotives
heating homes, factories, offices
running cars, trucks, buses, planes
resource for manufacturing products, fertilizer
Lighting houses and other buildings

The diagram above shows six *primary sources* of energy. Lines connect each primary energy source to the most important work it does. Which energy source is seldom used today? Which two do not involve burning to produce power? Which ones are used to make electricity?

Use the information on the chart and on the energy timeline to help you complete these four stories about the Spritz family.

1. In 1901, Great-grandma and Great-grandpa Spritz went by train to Niagara Falls for their honeymoon. The train engine burned ____________ to boil the water that made the ____________ that drove it. The *primary* source of energy was ________________. Not long ago their great-grandchildren flew by jet to California. The primary energy source that got them there was ________.

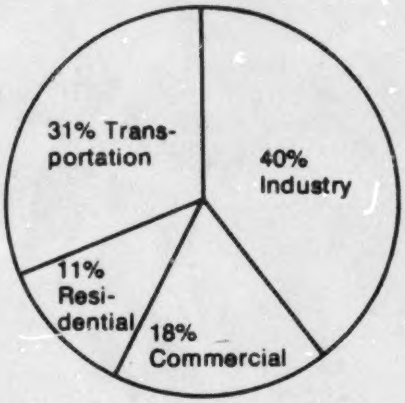
2. Great-grandpa Spritz was one of the first in town to drive an automobile. His Model T burned ______________. The primary source of this fuel is ____________. A Spritz great-grandson earns his living driving a big diesel truck. The primary source of this fuel is ____________.

3. Four generations of Spritzes have lived in the old family home. At the turn of the century, the family huddled around a stove in the parlor for warmth. Probably the primary energy source was ____________ In 1928 the family put in central heating by installing a furnace in the basement. The primary energy source was ____________. Since 1952 the Spritzes, like most Americans, have heated their homes with a primary energy source that is clean and convenient to use. It is ______________.

4. Recently a young Spritz asked how the electricity that lights the house and runs the appliances is made. His dad drew a picture of a giant wheel with blades. "This is a __________ engine," he said. "There are a number of these at our city's power plant. These giant wheels turn to make electric energy. Falling ________ or powerful blasts of ________ turn the wheels. You can't get steam, of course, without boiling water. And so a primary energy source furnishes heat to boil the water." The primary energy source that makes most of our electricity is coal. Other sources might be ________ or ______________ or ______________

Activity

Where We Get Our Energy
How We Use It



GRAPH A

Graph A divides our energy use into four groups. In what group do we use the most energy? ____________________

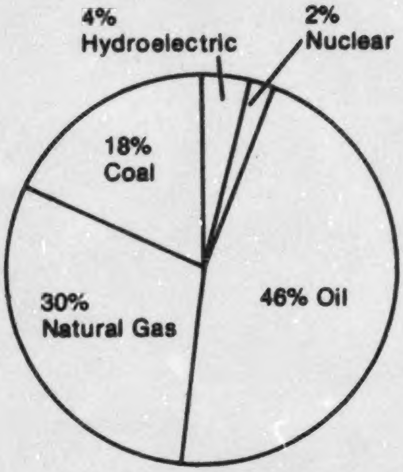
What ranks second? ____________________

In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns.

(The first one is done for you.)

	Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand				
3. Fly in an airplane				
4. Switch on air-conditioning				
5. Buy a new baseball				
6. Ride a school bus				
7. Blow dry your hair at home				
8. Buy a frozen pizza				
9. Ride a motor-bike				
10. Manufacture a motor-bike				



GRAPH B

Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most?

2. Which do we use mostly for heating our homes?

3. What energy source provides most of the fuel for our transportation?

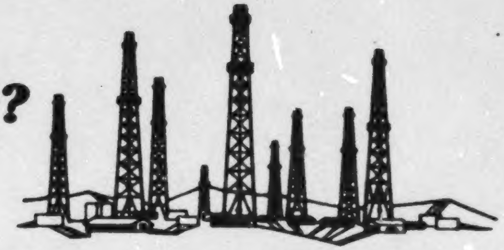
4. Which one makes most of our electricity?

5. What is a possible reason why we use so little hydroelectric energy?

6. Why is electricity not shown on this chart?

Activity

How Long Might Our Oil and Natural Gas Last?



Both liquid petroleum, which is more commonly called oil, and natural gas are fossil fuels. Like coal, they were formed by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth.

Gasoline that runs our cars, trucks, and planes is made from petroleum. So are paints, insecticides, fertilizers, and many other manufactured products. Natural gas is a clean-burning fuel that heats many of our homes, cooks our food, and serves industry. Together, oil and natural gas supply 76 percent of our total energy needs.

Read the following items; then see if you can determine how long our oil and natural gas resources might last.

Item #1: During 1975, the United States produced from oil wells about **3 billion barrels** of oil (a barrel holds 42 gallons).

Item #2: The Federal Energy Administration estimates that our proved oil reserves in the U.S. (those known to exist and to be recoverable) is **38 billion barrels**.

Item #3: Many geologists figure that it is fairly certain that an additional **27 billion barrels** of oil reserves exist.

If this amount of oil still in the ground were all we had, and if we did not increase or decrease our production each year, in about how many years would the U.S. run out of domestically produced oil? (Add #2 and #3, and divide by #1.)

(#2) ____________ billion barrels
+(#3) ____________ billion barrels
____________ billion barrels
÷ (#1) ____________ billion barrels
____________ number of years

Item #4: The highest estimate is as much as **127 billion barrels** of additional domestic oil still undiscovered.

If item #4 is true, and if we do not increase or decrease our production, how many years might our possible total oil resources last?

(On the back of this sheet, add #2, #3, and #4 and divide by #1. Put the number of years in this space.)

____________ number of years

In the same way, determine how long our natural gas resources might last.

Item #5: During 1975, the U.S. produced for use about **20 trillion cubic feet** of natural gas.

Item #6: Our proved reserves at the end of 1974 were **240 trillion cubic feet**.

Item #7: Fairly certain reserves of natural gas are about **202 trillion cubic feet**.

If this amount of domestic natural gas was all the supply we had, it would last about how many years? (Add #6 and #7, and divide by #5. Put the answer in this space.)

____________ number of years

Item #8: The highest estimate of undiscovered natural gas resources is **655 trillion cubic feet**.

If this amount is true, about how many years might our supply of natural gas last? (Add #6, #7, and #8, and divide by #5. Put answer in this space.)

____________ number of years

BUT . . . the United States is now using each year almost double the oil that it produces from its own reserves. Where does this additional oil come from?

What could happen if our usage continues to increase each year?

What if oil and natural gas usage increases in other countries?

At what time in your life could the U.S. run out of oil and natural gas?

Activity

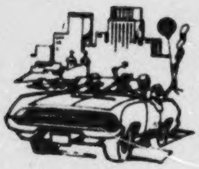
Supply and Demand; Shortage and Surplus

Finish the story by filling in the blanks. Think of the right answer. Then see if it appears in the answers below. Put its number in the blank. Some answers may be used more than once.

POSSIBLE ANSWERS

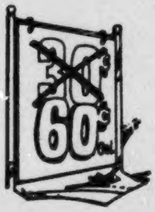
1. 40
2. lowered
3. supply
4. 200 gallons
5. $3.00
6. 5 gallons
7. shortage
8. raised
9. surplus
10. 160 gallons
11. demand
12. $60.00

Mr. Smith, a gasoline station owner, received 200 gallons of gasoline regularly each week. His 20 regular Smalltown customers were used to buying all the gas they needed. Although some weeks some people bought more and some bought less, average use was 10 gallons a week. The total demand for gasoline each week, then, was __________ As you have seen, Mr. Smith's supply was __________ Everybody was pretty happy about the whole thing. The supply was equal to the __________



Mr. Smith charged 30¢ a gallon for gasoline, a price that was about the same as that charged by the other station in town. Each regular customer spent an average of __________ each week. Mr. Smith received __________ for gasoline. When the other station reduced its price per gallon by a penny, four of Mr. Smith's regular customers deserted him and went across the street. He was still getting a delivery of 200 gallons a week, but now the demand was only __________ He had __________ gallons left over. This unbought quantity of gasoline is called a __________. To get rid of the surplus, Mr. Smith __________ his price. His other regular customers bought up the __________ and took a few more pleasure trips into the city.

Several weeks later, Mr. Smith and the other station each received only 100 gallons of gasoline. Their suppliers were short of gasoline that week. Their customers' demands were still the same, so the pumps soon became empty. "No More Gas!" the sign in front said. Halfway through the week. Mr. Smith had a __________ of gasoline. By still charging 30¢ a gallon, he didn't make enough to pay the costs of his station.



The next week he raised the price to 60¢ a gallon. Even at the higher price, most of his customers still had to buy gas to drive to work and do errands, so he sold all 100 gallons. How much money did he receive? __________ What was the average amount each of the 20 regular customers spent? __________. What was the average amount of gas each customer used? __________

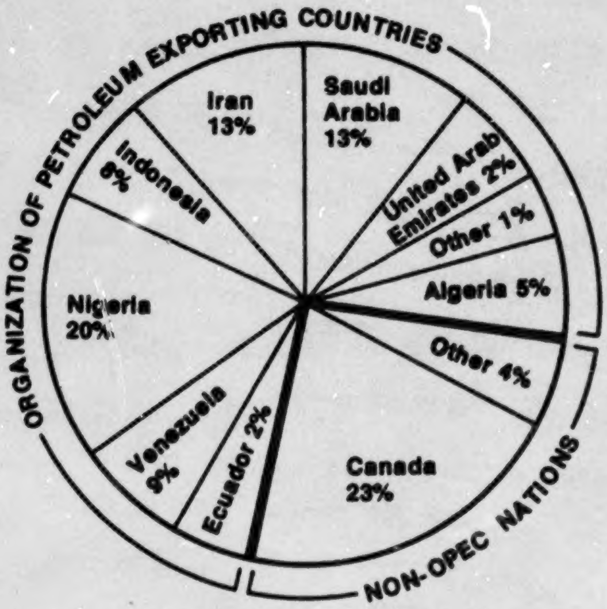
Some of Mr. Smith's customers were on a fixed budget and couldn't afford to spend more than $3 a week for gas. Some customers got to the station after the pumps were empty and couldn't get all they needed. Some of the other station's customers came over to Mr. Smith's station. The demand was greater than the __________ Mr. Smith __________ his gasoline prices again.

Discuss in your class ways in which the people of Smalltown might solve their gasoline supply problem.

Activity

The Oil We Import

Because America's demand for oil is greater than its supply, we must buy oil from other countries to help meet the demand. This is called *importing*. During the last five years our imports of oil have doubled, and the cost per barrel has increased more than four times.



PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1974

1. Find each country shown on the graph on a world map. Then list each country in its proper region below. Beside each country's name write the percentage of oil the U.S. imports from it.

North America

______________________ __________

Latin America

______________________ __________

______________________ __________

The Mideast

______________________ __________

______________________ __________

______________________ __________

Africa

______________________ __________

______________________ __________

Southeast Asia

______________________ __________

2. What do the letters OPEC stand for? (The OPEC nations have formed an association to regulate the price they charge for their crude oil.)

____

3. What percentage of imported U.S. oil comes from OPEC nations?

____

4. Which country sells the U.S. the most crude oil? (This country says it will need to end all shipments to the U.S. by 1982.)

____

5. Why does the U.S. need to import oil?

____

Check which of these solutions to our energy consumption problem seems workable to you.

☐ Increase domestic production of fossil fuels

☐ Decrease our demand for oil

☐ Develop new energy alternatives

☐ Increase oil imports to fill growing demand

☐ Stop importing; become energy independent

Other solutions (Could you name some?)

____

____

____

Activity

The Good Old Days?

Interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. Ask him or her the questions that follow and others that you think of yourself.

1. What kind of lights did you use in your home? ________________________
________________ How was it heated? ________________________
2. What fabrics were clothes made of? Was clothing harder or easier to take care of?
____
3. What sort of washing machine did you have? ________________________
4. What kind of stove (and what kind of fuel) did your family use for cooking?
____
5. Did you have a refrigerator? How did you keep your food fresh? ____________
____
6. How was food packaged when it came from the store? ______________
What did milk come in? ____________ Was your milk delivered? ________ How?
____
7. What sort of soap did you use? Did it clean as well as the cleaners we have now?
____
8. How was your water heated for bathing and laundry?
____
9. Did your family have a car? ________ If not, how did you travel? How did you get to school? ____
10. Did you have a radio? What did it look like? ________________________
________________________________ Did you go to the movies? ________
What kinds of entertainment did you enjoy? ________________________
____

(Think up as many more questions of your own as you can. Ask them during the interview. Put the answers on the back of this paper.)

To close the interview, ask these questions and write the answers on the back of this paper.

In what ways is life for you more enjoyable now that we have electricity, plastics, detergents, and other oil and natural gas products?

In what ways did you like the "good old days" better?

Activity

What Can YOU Do To Save Energy?

Part 1:

Brenda's mother and Wayne's father each work ten miles away from their homes. In a five-day week, each uses five gallons of gas driving to and from work. Wayne's father drives alone. Brenda's mother is in a car-pool in which she takes four other persons to work. If each of her passengers drove, each would also use five gallons of gas a week. Now that they car-pool, how much gasoline does Brenda's mother help save each week? ______________________
each year? ______________ How could Wayne's father help save energy? ______________________

The Bailey's are going away on vacation. They are concerned about burglars and want a light on in their house from 7:30 to 11 o'clock each evening. Can you suggest how they might do this without wasting energy? ______________________

Selecting the right size electric light bulb can help save energy. On the package is listed the number of watts (the amount of power needed to make the light bulb work), the lumens (the brightness of the bulb), and the number of hours the bulb will last. With this information, how could you select the most efficient bulb? ______________________
____
____

John and his sister are going to wash clothes. He wants to do his three shirts separately. His sister wants to do them with her five blouses. Which way will conserve energy? ______________________
______________ Why? ______________
____

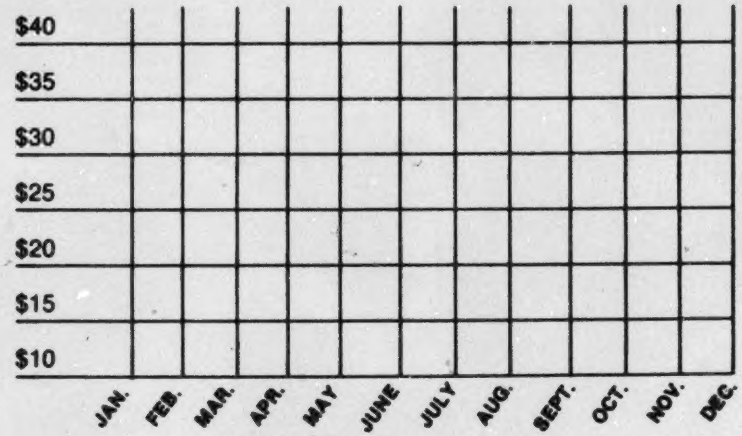
Jack has just come in the door after playing in the snow and feels too warm. He wants to turn down the thermostat until he feels comfortable. His mother tells him to leave it where she has set it at 68 degrees. Who is more energy-conscious? ______________________
Why? ______________________
____

Part 2:

Below are the Hazleton's heating and air conditioning bills for two different years. In 1974, they had no insulation in their home. At the end of the year they had some installed, so the cost of heating and air conditioning in their home went down. In the graph below, place a dot for the cost of each month in 1974. Then draw a line between the dots. Do the same thing for 1975 in red. Compare the Hazleton's savings with insulation.

How much did they save in January? ______________
How much for the entire year? ______________

	1974	1975
January	$35	$25
February	$25	$20
March	$20	$20
April	$20	$15
May	$15	$10
June	$25	$15
July	$40	$25
August	$35	$20
September	$20	$15
October	$15	$15
November	$20	$15
December	$25	$20

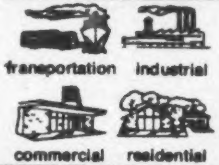
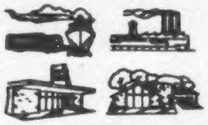
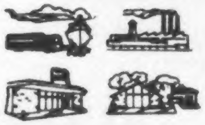
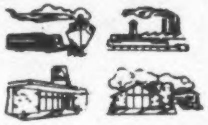
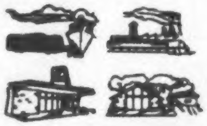
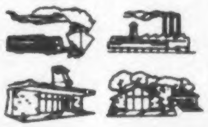


1. At what time(s) of the year is there the highest utility cost? Why?
2. At what time(s) of the year is there the greatest savings after insulation?

Activity

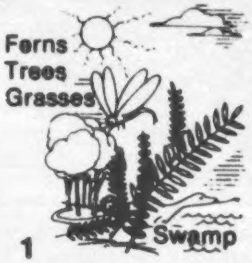
It's Everyone's Job!

Read the idea for conserving energy in the column headed **Conservation Method.** Then answer the questions in the spaces provided.

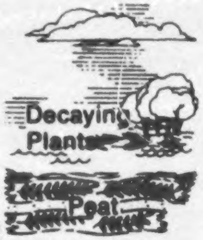
Conservation Method	What sector of society? (circle one or more)	What energy resources does this save? (write: natural gas, petroleum . . . or coal)	Does it use less energy? (Yes or No)	Does it use energy more efficiently? (Yes or No)	How can we encourage this conservation measure? (brainstorm as many ideas as you can)
Flying passenger airplanes only when they are full					
Shipping freight by train instead of truck					
Replacing incandescent light bulbs with fluorescent lights					
Reducing heating and cooling where space is unoccupied					
Recycling, steel, paper, glass, aluminum					
Developing and using mass transit systems					

Fossil Fuels: Coal, Oil, and Natural Gas Activity

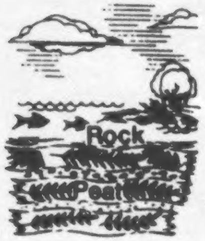
HOW COAL WAS FORMED



1



2



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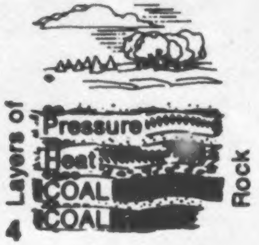


4

PLACE THE NUMBER OF EACH PICTURE IN FRONT OF THE DESCRIPTION THAT FITS IT BEST.

_____ When the giant plants died, they formed rotted vegetable matter called *peat*. For thousands of years, plants grew, died, and formed layer upon layer of peat.

_____ When the seas were gone again, heat and pressure from the layers of rock changed the peat into coal.

_____ More than 250 million years ago, forests of gigantic ferns, trees, and grasses covered vast swamp lands and stored up energy from the sun.

_____ Later, when the surface of the earth changed, seas covered the land and deposited layers of shale, limestone and other rock on the peat.

HOW COAL IS MINED

Strip or Surface Mining
Uses huge bulldozers and power shovels to remove coal from a shallow seam near the earth's surface.

Deep or Underground Mining
Tunnel or shaft is built into the earth to the seam of coal sometimes many hundreds of feet below the surface. Workers and equipment remove the coal through the tunnel or shaft.

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal? Write your choices on the blanks at the left, using S (for surface) or D (for deep).

		SURFACE MINING	DEEP MINING
_____	1.	Each miner can produce 30 tons of coal a day.	Each miner can produce 10 tons of coal a day.
_____	2.	90 percent of the coal in a surface mine can be removed.	50-60 percent of the coal in a deep mine can be removed.
_____	3.	In 1974, surface-mined coal cost $11.11 a ton.	In 1974, deep-mined coal cost $19.86 a ton.
_____	4.	Forest and fields, along with their topsoil, are turned over before the coal is removed — at a rate of 1000 acres a week. New laws in every state require land reclamation, but the cost is added to the price of coal.	Much less damage to land and environment.
_____	5.	Some coal, very close to the earth's surface, can only be recovered by surface mining.	Some coal, very deeply buried, can only be recovered by deep mining.

It would be easy to decide how to mine coal if there were only one set of facts to consider. As you have seen, however, there are many. What would you say is the main advantage of surface mining?

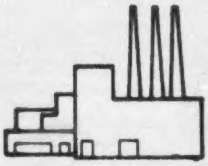
What would you say is the main advantage of deep mining?

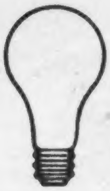
Can you think of a compromise?

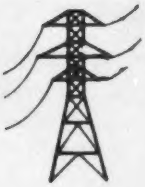
Activity

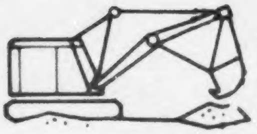
How Coal is Used

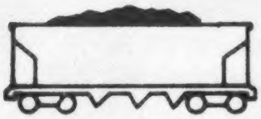
This activity follows coal from the mine to your electric light.

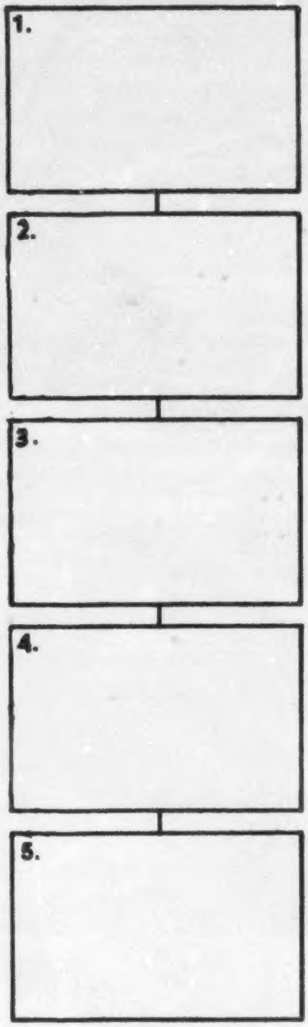












1. Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted.
2. About 2/3 of our coal is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip.
3. 46 percent of U.S. electrical generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine, a series of wheels with vanes like a windmill. The turbine rotates coils of wire in a generator through a magnetic field to produce electricity.
4. Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.
5. Electricity lights the lamps in your home. How many other uses of electricity in your home can you name? Write them on the back of this paper. Then place a star before those you think you could do without.

Some Facts About Coal

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O — or both — in each blank. On the back of this sheet, write down ways some of the problems could be overcome. Compare ideas with your classmates.

______ 1. 90 percent of U.S. fossil fuel reserves (coal, oil, natural gas) are coal.

______ 2. Some deep mines are dangerous.

______ 3. 50 percent of our mineable coal is in the western United States.

______ 4. We have enough coal to last for 350 years, at current level of use.

______ 5. Mining coal can cause damage to the environment.

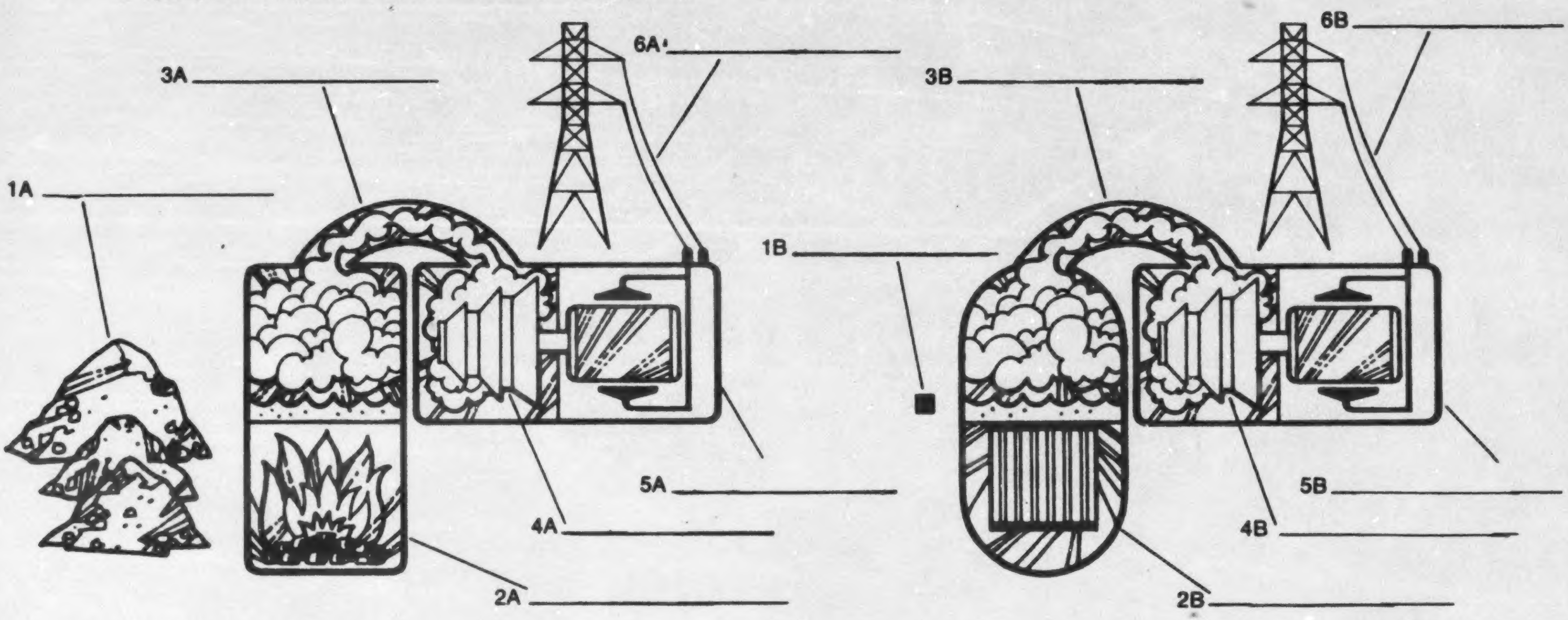
______ 6. In the future, we will rely more on coal as a source for synthetic oil and gas.

Activity

Nuclear Energy (PART 1)

One of the energy resources being considered to supplement our limited oil and natural gas supplies is nuclear power, created by the splitting apart of atoms of uranium. This power can be captured and used to create steam which produces electricity much as the power of burning coal is used in an electric generating plant.

The diagrams below show two kinds of electric power plants. They are much alike except that one is powered by nuclear energy produced in a nuclear reactor. Can you label the parts of the two plants. All the words you need appear at the bottom of the page. An encyclopedia or other reference book may help you.



A ______________________________

B ______________________________

FOSSIL FUEL ELECTRIC GENERATING PLANT
NUCLEAR POWERED ELECTRIC GENERATING PLANT

GENERATOR
BOILER
STEAM
TRANSMISSION LINES

TURBINE
TRANSMISSION LINES
FUEL (1 lb.)
TURBINE

STEAM
REACTOR
GENERATOR
FUEL (2½ million lbs.)

Activity

Nuclear Energy (PART 2)

The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in bold type. Read the list and put a (B) in the blank if it is a benefit, a (P), if it is a problem.

— LESS NEED FOR MINING AND **TRANSPORT** OF FUEL

— NO **POLLUTANTS** FROM BURNING FUEL

— LESS RELIANCE ON **IMPORTED FUEL**

— COULD BE TARGETS FOR **TERRORISTS**

— REACTORS PRODUCE **LESS WASTE** THAN FOSSIL FUEL PLANTS DO

— OVERALL **COST** OF ELECTRICITY WILL BE LESS THAN WITH FOSSIL FUELS

— HIGHER **COST TO BUILD**

— LARGE AMOUNTS OF **PLUTONIUM** COULD LEAD TO SPREAD OF NUCLEAR WEAPONS

— POSSIBILITY OF **RADIATION ESCAPING**

— **RADIOACTIVE WASTE** MUST BE HANDLED AND DISPOSED OF SAFELY FOR THOUSANDS OF YEARS

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) expansion of nuclear energy. Complete the arguments by inserting a KEY WORD (above) into the blanks for each problem area.

PRO: The ______________________ is made into a type of glass or ceramic, put into special containers, and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the ______________________ to lose its radioactive properties. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by ______________________.

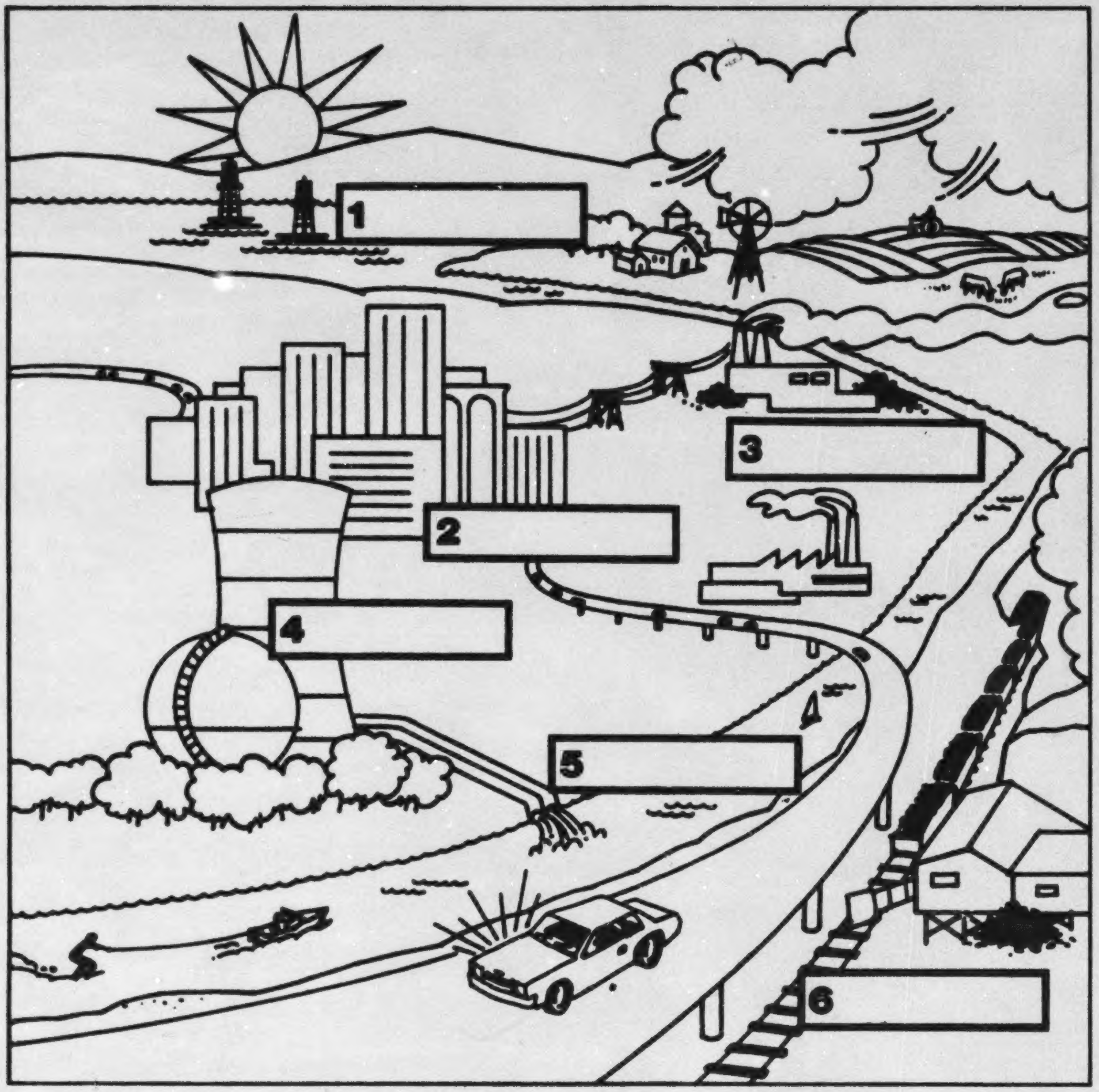
CON: There's always a chance that an accident or mechanical malfunction could present the danger of ______________________.

PRO: Regulations and safeguards can be strictly enforced to keep the ______________ out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive ______________ is enough to make an atom bomb.

A Delicate Balance (PART 1)

Activity



1. Name the possible sources for energy in the picture. ____________________

2. What energy sources shown are used to generate electricity? ____________________

3. Seven types of environmental pollution concern us today: air, water, thermal (heat), radioactivity, visual, noise, and land disruption. In the boxes on the picture above, write in the type of possible pollution occurring in that part of the picture.

4. How do different parts of your environment—air, water, land, people, city, country—affect each other?

5. To help keep that delicate balance between meeting our energy needs and maintaining a clean and healthy environment, what in your life would you be willing to change?

Activity

A Delicate Balance

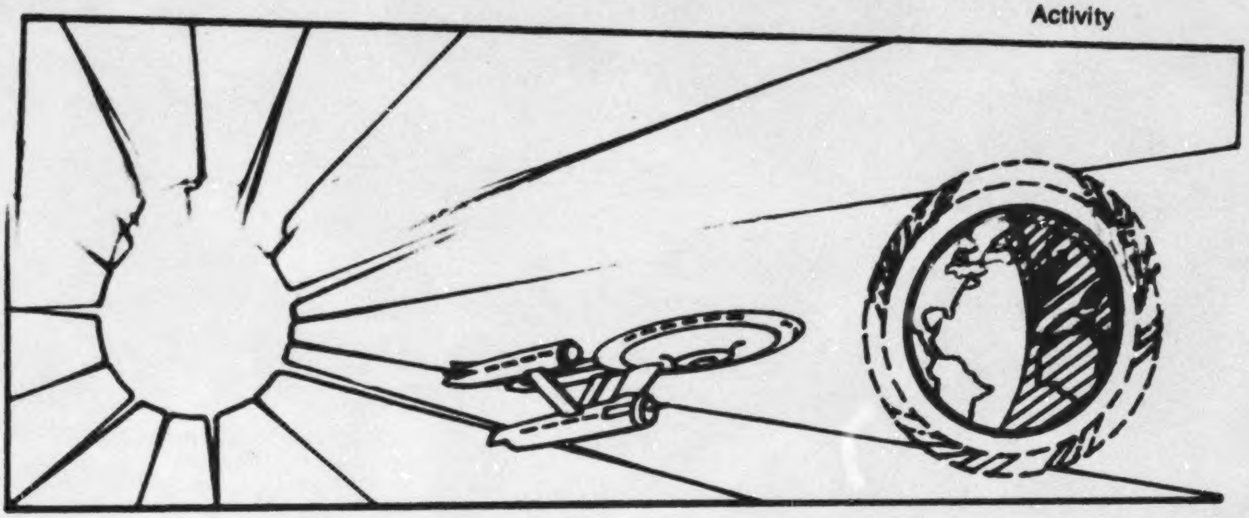
(Part 2)

From the clues given on the chart below, identify each type of pollution: water, air, or land disruption. In the last column of the chart, place the number of the choice listed here that you agree with.

1. "I know I will have to spend more dollars to pay for electricity, fuel, gasoline, and other energy-related products so that energy producers can pay for environmental controls."
2. "I will cut back on my own energy use — really practice conservation."
3. "I will support more government regulations."
4. "I can count on business and industry to find the answers."
5. "I'm willing to live with pollution."
6. If you can think of other solutions, write them down.

TYPE OF POLLUTION	WHAT IS IT?	WHAT CAN IT DO?	HOW CAN IT BE IMPROVED?	WHAT WOULD I BE WILLING TO DO?
	It is the adverse effect from burning coal and oil, and from car exhausts. It is high concentrations of carbon monoxide, sulfur dioxide, and unburned ash.	It can increase respiratory illnesses and raise death rates. It can damage crops, plants, and trees.	By installing emission controls on autos and filters or traps on chimneys. By cutting down on the burning of coal and oil. By burning solid wastes in closed incinerators. By capturing and reusing industrial gases for other products.	
	It is the use of millions of acres for mining, development of power plants, refineries, transmission lines, energy-resource storage, and solid waste disposal.	It can disturb wilderness and recreation areas. It can destroy vital plant-animal food chains and can cause erosion and loss of soil nutrients.	By reclaiming mine sites. By landfilling and recycling solid wastes. By replanting vegetation, reforesting, building lakes and recreational parks.	
	It is high amounts of impurities such as disease-causing organic wastes, toxic substances such as acids and pesticides. It can be caused by oil spillage, offshore construction, industrial waste, and municipal sewage.	It can disturb or destroy fish breeding and feeding grounds, can cause taste and odor problems, clog streams, destroy recreation areas and sometimes cause disease in humans. Mines can contaminate ground water.	By installing filters, aeration and settling devices. By breaking down impurities with chemicals. By cleaning up rivers and shorelines. By transforming acid wastes to useful by-products.	

THINK ABOUT IT: Make a list of things you can do today to help stop pollution.
Start with these: Don't litter. Recycle. Use public transportation. Don't burn rubbish or leaves. Can you add to the list?



Let's Power Spaceship Earth With the Sun

The sun, 93 million miles away from earth, sends more radiant energy toward us every second than people have used in the course of human history. Thirty percent of this energy is reflected back into space by our atmosphere. Much of the remaining radiant energy of the sun heats the land and the water; it evaporates water and melts the snows. It is the source of energy that creates the winds and great ocean currents, and it warms the atmosphere that surrounds us.

Energy from the sun interacts with oxygen at the top of the earth's atmosphere to create a layer of ozone that protects us from lethal amounts of the sun's radiation. Solar energy reacts with plants in the chemical process of photosynthesis to provide the stored energy that fuels life. Coal and oil and natural gas, once swamp jungles of the ancient earth, are stored solar energy. All of these are ways we benefit from the sun's energy directly.

We also benefit indirectly from the sun's energy when that energy comes to us "secondhand." The electricity generated by a windmill, for example, is the sun's energy once removed. So, too, is the energy our bodies get from the food we eat.

Less than one percent of the incoming solar energy is used to sustain plant and animal life, yet this amount is many times greater than the total electric generating capacity of the entire world. the sun could be an important answer to our energy dilemma. All we have to do is find the key to the bank.

Humans from the dawn of history have put the energy from the sun to work to keep warm or to grow food, or by harnessing the wind. In what ways did early people use the sun to do work for them?

What has the energy from the sun made possible in your life today?

Put a D beside each of the following things that result from energy received directly from the sun. Put an I beside each thing that results indirectly from the sun's energy.

—— coal deposits

—— sailboats

—— salt flats

—— gasoline

—— photosynthesis

—— mountain streams

—— Hoover Dam

—— sugar cane

—— candy bar

—— electric heater

—— leaves turning green

—— ocean currents

—— steam engine

—— ozone layer of the atmosphere

THINK ABOUT IT:

1. Why is the sun called the source of all energy except nuclear?

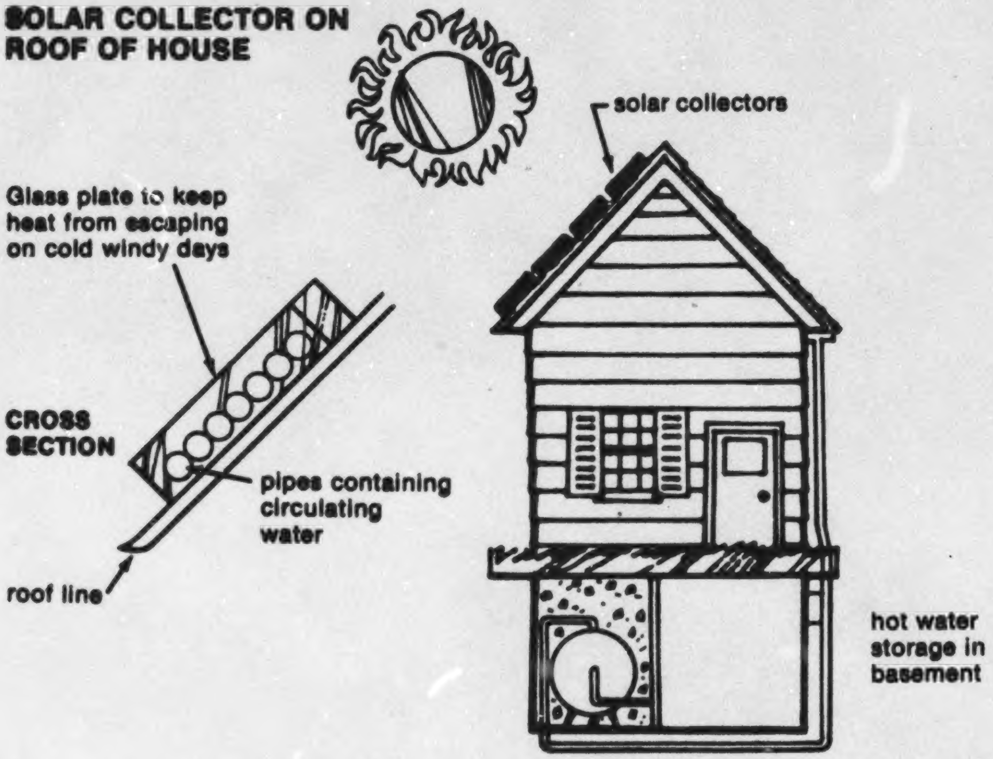
2. Imagine life on earth in the future if we learn to harness the power of the sun to provide heat, light, and electricity. What problems would be solved? What problems might be created?

Activity

Energy from the Sun (Part 1)

There are several ways to use solar (sun) energy. One way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning, and water heating, but not its electric power. Another is to build huge solar farms to collect solar energy, turn it into heat and then to electricity that will be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.

SOLAR COLLECTOR ON ROOF OF HOUSE


solar collectors
Glass plate to keep heat from escaping on cold windy days
CROSS SECTION
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the U.S. would be able to use solar heat without a conventional back-up furnace?

2. What side of the roof should the collectors be mounted on?

3. Why is the inside of some types of collectors lined with mirrors?

4. Will the heat from roof collectors be used to generate electicity?

5. Could the heat from solar farm collectors be used to generate electricity?

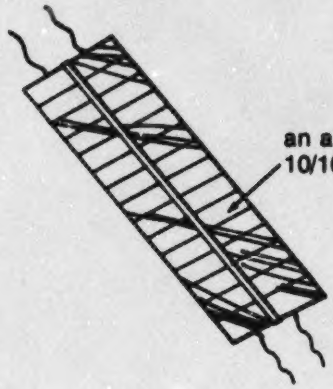
6. The U.S. Energy Research and Development Administration foresees as much as 25 percent of our energy needs filled by solar technologies by the year 2020. Why will it take so long?

Activity

Energy from the Sun (Part 2)

SOLAR CELL

This device converts sunlight directly into electricity, with no moving parts and no pollution.



an array of thin silicon cells 10/1000 in. thick

wires lead to electrical batteries which power lights and motor-driven appliances.

1. Solar cell systems are now used to power spaceships and ____________________

2. We probably will never run out of silicone as a resource because it is the second most plentiful substance on earth. Do you know its more common name? ____________________

3. If it now costs $20 a watt to generate electricity by means of solar cells, how much would you have to spend on equipment to power just the 100 watt light bulbs in your house? __________
____

4. What do we need to do before we can use solar cells as an energy source? __________
____

5. How can electricity be stored to use later? ____________________
____

THE ADVANTAGES AND THE DISADVANTAGES OF SOLAR ENERGY

DISADVANTAGES

1. Expensive to install
2. Requires a great deal of space
3. The sun doesn't always shine
4. Would mean modification of housing in many cases
5. New laws would be needed concerning construction that might cast shadows

ADVANTAGES

(See if you can supply the advantages. What is good about solar energy in regard to each of the following?)

1. Supply. ____________________
____

2. Pollution. ____________________
____

3. Embargoes. ____________________
____

4. Cost. ____________________

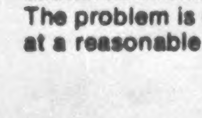
Activity

Other New Energy Resources

Besides nuclear and solar energy, there are several other possibilities for the future. Read about some of these new energy sources on this page. Problems and solutions are associated with each of them. On the next page you will decide what some of these problems and solutions are.

WIND. Wind is actually a form of solar energy since it is caused by variations in the temperature of the air heated by the sun that causes air to move. Sailors used this energy for ages. For many years farms have used windmills to generate electricity. Maybe giant windmills will someday be able to provide electricity for entire towns. The major difficulties are that the wind doesn't blow all the time and that practical storage systems are still being developed.

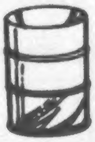
GEOTHERMAL. The earth's center is a molten mass. In some areas this mass is close to the surface. Some evidence of this are volcanos, geysers, and hot springs. This heat can be trapped and used to generate electricity to supply cities without polluting the atmosphere. The problem is that this energy can now be tapped only where it is near the surface. Scientists are searching for other areas where this geothermal energy can be reached, but they don't have all the answers yet.



PYROLYSIS OF SOLID WASTE. It is possible to heat waste in an oxygen-free atmosphere and produce oil and gaseous products. This waste is what we're now having trouble removing from our environment: manure, garbage, paper, logging residue, some industrial waste, sewage, and the like. The difficulty is that this material tends to be scattered in small amounts at various sites. The problem is one of gathering it together at a reasonable cost.

COAL GASIFICATION. By using high temperature and pressure, coal can be converted into a gas very much like natural gas. Building these conversion plants near coal fields can solve the problem of transporting bulky fuel that gives off pollutants when it is burned. When coal gas is burned, it burns as cleanly as natural gas, causing virtually no air pollution. The usual pollution problems occur in the coal mining process, however, as they always have. The conversion process itself, however, uses large amounts of electrical energy.

COAL LIQUEFACTION. Although the technology is not completely developed, coal can be converted to an oil-like liquid. It has the advantage over coal gas of being usable to make all the usual oil products, including a kind of gasoline to run our cars.



OIL SHALE. Oil shale is a rock containing a material that yields oil when it is crushed and heated. One ton of rock will produce about 25 gallons of oil. Most oil shale deposits are in the West. The rock must be mined, either by deep mining or surface mining. Extracting the oil takes large amounts of water — three barrels to every one barrel of oil processed. One of the big problems is the disposal of the spent rock after the oil is extracted. Vegetation will not grow on the used shale without a moderate amount of rain — scarce in many parts of the West. Without vegetation, some animals may lose their homes and natural food supply. Rain water passing through this rock will possibly pick up pollutants and carry them to larger bodies of water if there is no vegetation. In addition, oil shale processing contributes to air pollution.

Problems/Solutions

Activity

In this unit, you have learned about eight new energy resources. The use of any one of these resources may help to supply our energy requirements but may at the same time present us with new problems to consider. In the lefthand column of this page are some of these issues — some are problems, some are solutions. Mark each statement S (for solution) or P (for problem). Place a checkmark in every energy-resource column on the right to which a statement applies. The first one is done for you.

	IF THIS ENERGY SOURCE IS USED, IT . . .	SOLAR	NUCLEAR	WIND	GEO-THERMAL	COAL GASI-FICATION	COAL LIQUI-FACTION	OIL SHALE	PYROL-YSIS
______	WOULD HELP SOLVE THE PROBLEM OF SOLID WASTE DISPOSAL.	✓		✓	✓	✓	✓		✓
______	COULD POLLUTE WATER.								
______	WOULD CONSERVE THE DWINDLING RESERVES OF FOSSIL FUELS.								
______	COULD DAMAGE WILDLIFE OR THEIR HABITAT.								
______	WOULD BE DIFFICULT TO STORE AND TRANSPORT.								
______	WOULD NOT POLLUTE THE ATMOSPHERE.								
______	WOULD DISRUPT THE NATURAL USE OF LAND SURFACES.								
______	WOULD NOT BE ABLE TO SUPPLY ENERGY ALL THE TIME.								
______	WOULD HAVE TO WAIT UNTIL THE TECHNOLOGY IS DEVELOPED.								
______	WOULD USE LOTS OF WATER TO PROCESS.								
______	WILL DECREASE THE NEED FOR OIL IMPORTS.								
______	WILL MAKE LARGE AMOUNTS OF WASTE MATERIAL.								
______	WILL MAKE USE OF THIS COUNTRY'S MOST ABUNDANT FOSSIL FUEL								

Activity

Hidden Word Review

Hidden in the diagram are energy-related words that you have met throughout *The Energy Challenge* activity program. There are 30 words altogether. Try to find as many as you can and circle them across, down, or diagonally. The letters of each word are always in sequence. You can answer the questions on this page with words from the puzzle.

T	R	A	I	N	C	E	M	B	A	R	G	O	P	G
E	N	V	I	R	O	N	M	E	N	T	A	L	R	E
L	U	M	E	I	N	S	T	E	I	N	S	I	I	O
E	C	A	P	D	S	R	O	Y	B	L	O	F	M	T
C	L	U	S	Y	E	P	L	L	U	T	M	E	A	H
T	E	I	U	M	R	M	E	R	A	M	U	S	R	E
R	A	N	P	B	V	O	A	C	A	R	S	T	Y	R
I	R	S	P	A	A	Z	L	N	E	R	N	Y	E	M
C	L	U	L	W	T	R	L	Y	D	O	I	L	C	A
I	O	L	Y	I	I	E	R	A	S	B	C	E	L	L
T	W	A	T	T	O	N	B	E	Y	I	P	R	O	S
Y	A	T	L	L	N	I	D	E	L	O	S	E	A	M
B	O	E	G	A	S	I	F	I	C	A	T	I	O	N
B	P	O	P	U	L	A	T	I	O	N	L	I	H	P
S	E	C	O	N	D	A	R	Y	E	N	E	R	G	Y

1. In 1776, James ______ put the steam engine to work and started an energy revolution.

2. Albert ______ prepared the way for the atomic age in 1905.

3. The three fossil fuels are ______, ______, and ______.

4. About 65 percent of our coal supply is used to generate ______.

5. A ______ of coal is a layer of coal lying beneath the surface of the earth.

6. Electricity is not a primary energy source; it is a ______ source.

7. Oil is measured by the ______, which is the same as 42 gallons.

8. Burning solid wastes at high temperatures without oxygen is called ______.

9. An almost inexhaustible source of energy that does not pollute, is inexpensive to maintain but costly to install is ______ energy.

10. Sunlight can be captured using a solar ______ to provide electric power to a building.

11. Being careful about the amount of energy we use, by practicing ______ we can save valuable energy.

12. If you ______ your house you can keep the heat in in the winter and out in the summer.

13. Shipping freight by ______ rather than by truck is much more energy-efficient.

14. Coal ______ turns coal into a clean, easily transportable fuel that can be used like natural gas.

15. The Organization of Petroleum Exporting Countries is usually abbreviated ______.

16. As a result of the oil ______ in 1973, there was a shortage of gasoline and fuel oil.

17. One of the worst sources of pollution in the U.S. is ______ without emission control devices.

18. Prices very often go up or down because of supply and ______.

19. More and more people in every country in the world means a ______ growth that will use more and more energy in the years to come.

20. We will have to reach a delicate balance between ______ concerns and our growing need for ______